WIRELESS ENGINEER

THE JOURNAL OF RADIO RESEARCH & PROGRESS

OCTOBER/NOVEMBER 1950

VOL. XXVII TWO SHILLINGS AND SIXPENCE No. 325-26

Your designs

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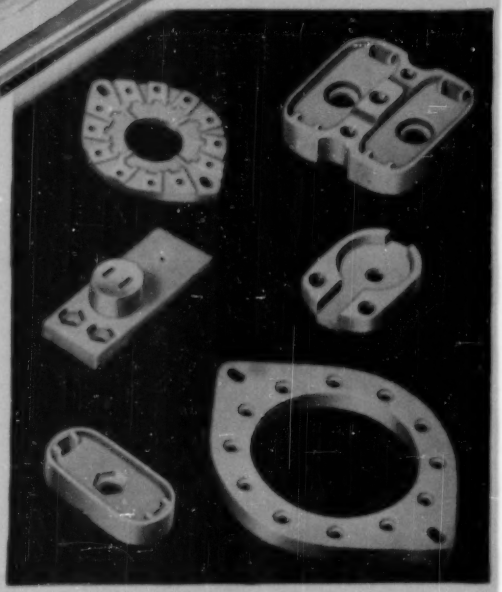

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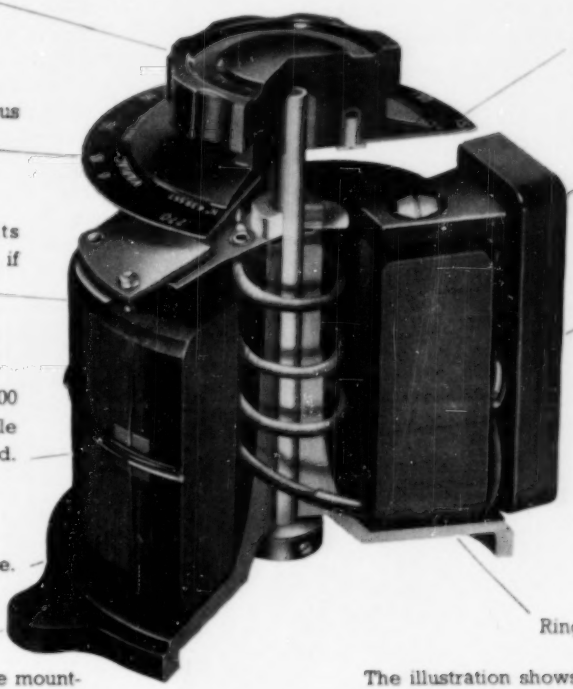

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Output independent of load.

Single or duplex voltage outputs. (Type 100 RM/2B)

Supplied with or without screen.

Ring-type laminated core.

The illustration shows Types 200 (580 and 860 va). Larger types are made-up to 7 Kva.

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For all measurements based on potential difference

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WESTON STANDARD CELL	TYPE D-402
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Measures from −0·01 volt to +1·92 volts on three ranges of ×1, ×0·1 and ×0·01.

Smallest subdivision on ×0·01 range, 10 microvolts.

Small negative reading ensures absolute zero volts position.

Accurate current control by stud rheostat and slide wire.

Separate standard cell balancing circuit.

Terminals for two external circuits selected by switch.

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C.R.C. 35

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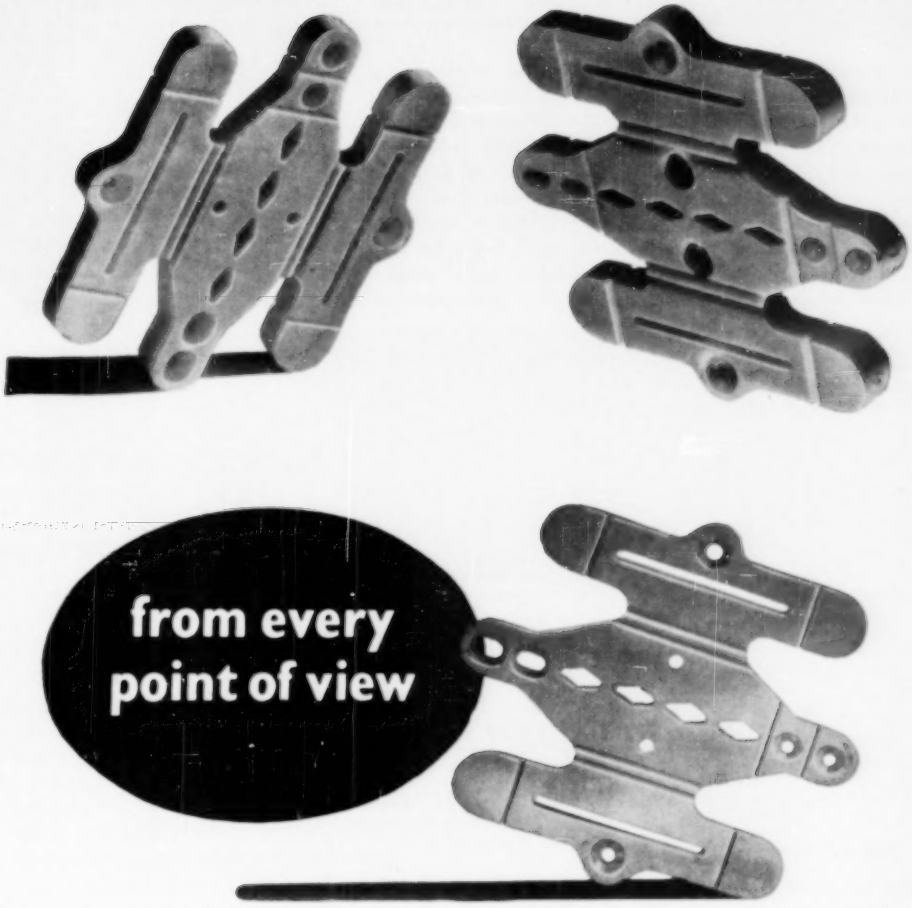

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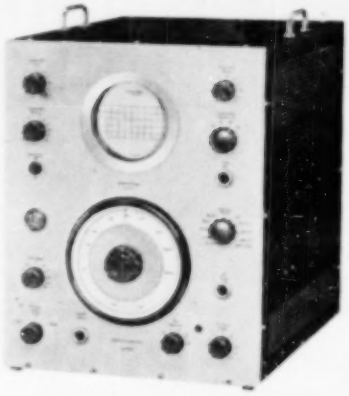
S.P.66

FREQUENCY RESPONSE TRACER

Type 4703

is primarily intended for the recording of frequency response characteristics of radio receivers, amplifiers, transmission lines, filters, etc., and for electro-acoustic investigations of loudspeakers, microphones and telephones. The instrument comprises a cathode ray tube with a long persistence screen, a logarithmic Y-amplifier and a motor-driven beat-frequency oscillator connected with the X-plates of the cathode ray tube. An R-F oscillator, modulated with the audio-frequency, enables direct input on the aerial socket of a radio receiver.



Specification:

Frequency Range: 0-20,000 c/s.

Frequency Accuracy: 1% ± 1 c/s.

Attenuator: Damping in steps of 10 db from 0 to 90 db.

Output Impedance: 6-60-600 and 6,000Ω.

Output Voltage: By matched load the voltage varies less than ± 0.5 db between 50 and 10,000 c/s.

Wave Form: The total harmonic content is less than 1% at 800 c/s and 0.5 watt.

R. F. Oscillator: Tuned to 1 Mc/s and modulated 30%.

Cathode Ray Tube: The dimensions of the trace area are 85 x 50 mm. (5-inch tube) Long Afterglow.

Logarithmic Amplifier: The range is 50 db. Zero level is 20 mV. Level ranges of 25 db and 10 db are obtainable to special order.

Writing Speed: Variable between 250 and 1,500 db/sec.

Frequency Response: Linear to ± 0.5 db in the frequency range from 50 to 10,000 c/s.

Dimensions: 19 (height) x 15 (width) x 24 (depth incl. dials) inches.

Manufactured by

Brüel & Kjær

Nærum, Denmark

Further information on request

NOT-so-simple Arithmetic

FROM one extreme to the other! From the simple arithmetic of 15 + 12 + 8 = 35, representing the number of individual types and sizes of current R. & A. Reproducers, to

$$\int dx = R + A$$

a modified calculus expression meaning something far less tangible but equally important.

It represents the integration of all the little bits of experience and know-how, all the countless refinements of design and technique, accumulated by R. & A. during 20 years of specialised loud-speaker manufacture for the equipment making industry.

Twenty years is a long time for the solution of any problem and we don't pretend to have the final answer even yet; but we genuinely believe that the "sum of all the elements" of our particular "x" puts us nearer to it than most people.

As a first step towards proving our case, may we send you our current leaflets, so that you can select samples for test?

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LOW FREQUENCY OSCILLATOR

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This is a new oscillator with constant output down to 1.1 c/s for the testing, calibration and set-up of biological amplifiers and recorders, strain and vibration recorders, and low frequency wave analysers.

It has a resistance capacity circuit of special design with automatic amplitude control to ensure constant output and good waveform at frequencies from 1.1 to 5,000 c.p.s. The circuit is remarkably free from trouble associated with change of valve characteristics, ensuring that accuracy is dependent only upon the frequency selective network components.

An incremental frequency switch is included specifically for the measurement of 'Q' in frequency selective circuits of filters or wave analysers.

Further details will be given on request.

- ★ FREQUENCIES DOWN TO 1.1 c/s
- ★ WIDE RANGE
- ★ CONSTANT OUTPUT VOLTAGE
- ★ HIGH STABILITY
- ★ OUTPUT ATTENUATOR
- ★ COMPACT AND PORTABLE
- ★ FREQUENCY INCREMENT SWITCH FOR Q MEASUREMENT
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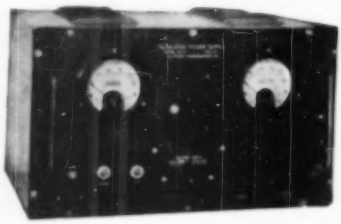

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MODEL 101-B.

Output : 200/350v. 0.250mA max.
Stability : Better than 0.1%.
Output Impedance : Less than 1 ohm.
Output Ripple : Less than 2mV. R.M.S.
Mains Supply : 200/250v. 45-60c/s.

Stabilization and regulation are maintained for all output currents from zero to 250mA and for mains voltage variation from + 10% to −15%.

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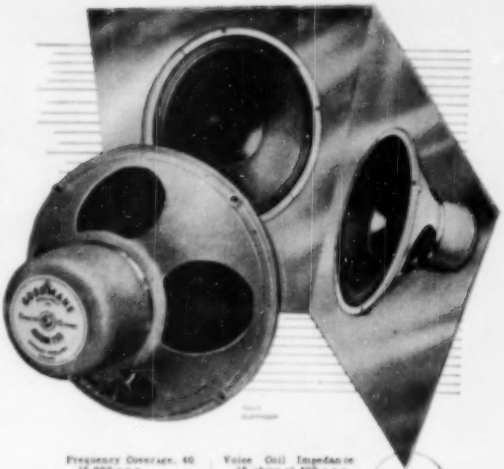
This 12in. high fidelity unit has a twin-curvilinear diaphragm (patent No. 451754). A carefully designed magnet assembly using anisotropic material provides a total flux of 158,000 maxwells on a 1¼in. pole. The back centring device is a dustproof bakelised linen disc with concentric corrugations.

The combination of these features gives this precision-built instrument an outstandingly wide coverage from 40 to 15,000 c.p.s. free from bass modulation effects.

An ideal high fidelity reproducer for the record enthusiast and the connoisseur of wide range musical reproduction, it gives exceptionally fine transient and frequency response.



Frequency Coverage, 40 - 15,000 c.p.s.
Overall Diameter, 12⅝in. - 31.3 cm.
Overall Depth, 6 15/16in. - 17.6 cm.
Fundamental Resonance, 50 c.p.s.
Voice Coil Diameter, 1¼in. - 4.4 cm.
Voice Coil Impedance 15 ohms at 400 c.p.s.
Maximum Power Capacity, 15 watts Peak A.C.
Flux Density, 14,000 gauss
Nett Weight, 12 lb. 13 oz. - 5,810 grammes.
Finish, Grey Rivelline Enamel.

£8 8s LIST

For use with this model we recommend Goodmans High Fidelity Heavy Duty Output Transformer Type H.4. Nett Weight 5 lb.—2,265 grammes.

A Bass Reflex Cabinet measuring approximately 30in. x 23in. x 16in., and a corner cabinet have been specially designed for this loudspeaker and working drawings are available.

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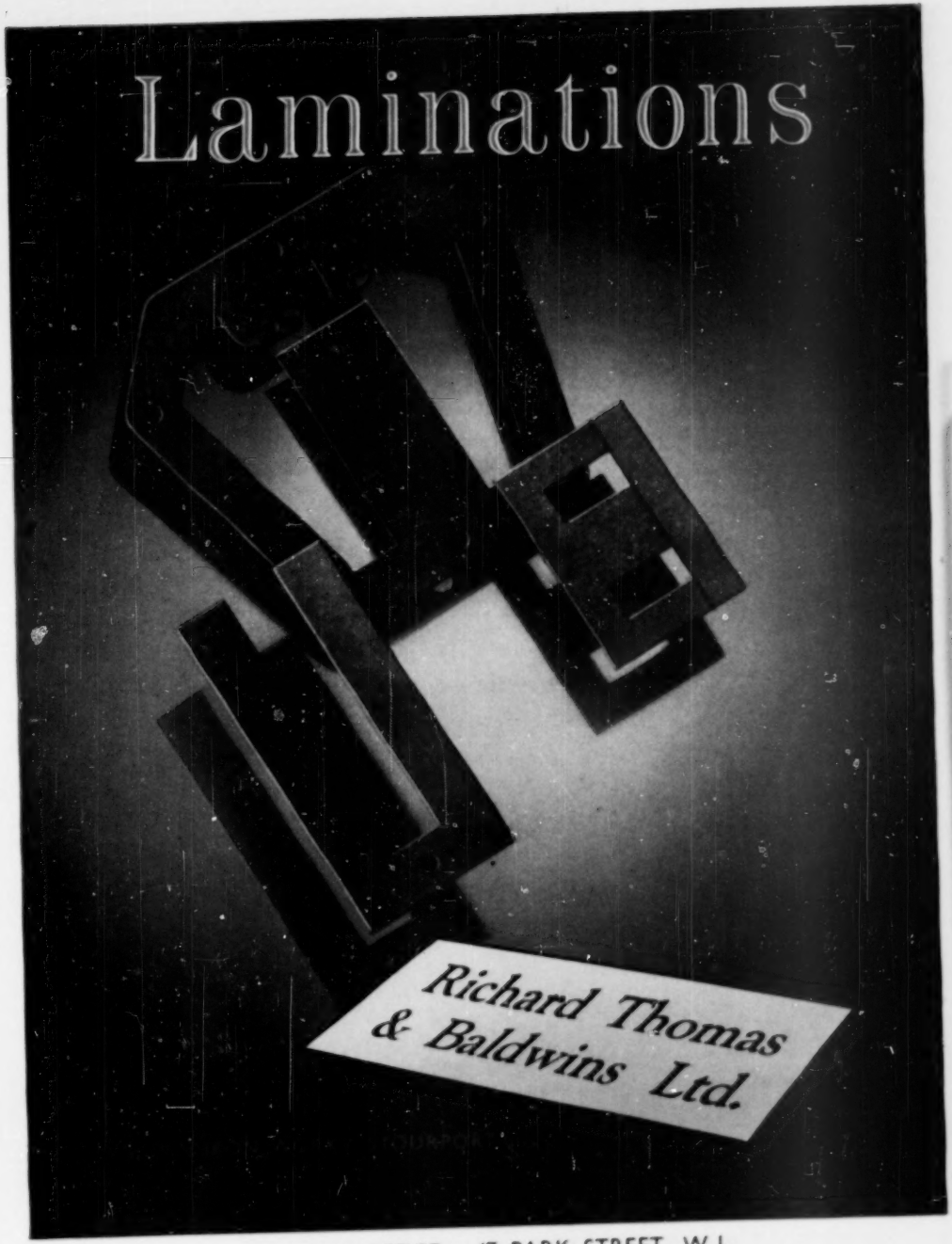

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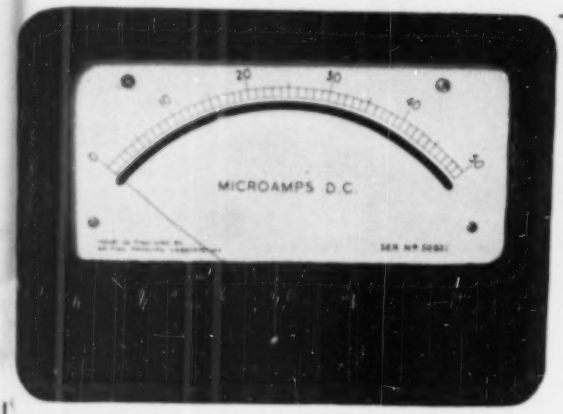

SIZE	2½"	3½"	5"
RANGE	25μA to 50A	10μA to 50A	10μA to 50A
PRICE			
50μA	55/-	61/-	63/-
200μA	45/-	51/-	83/-
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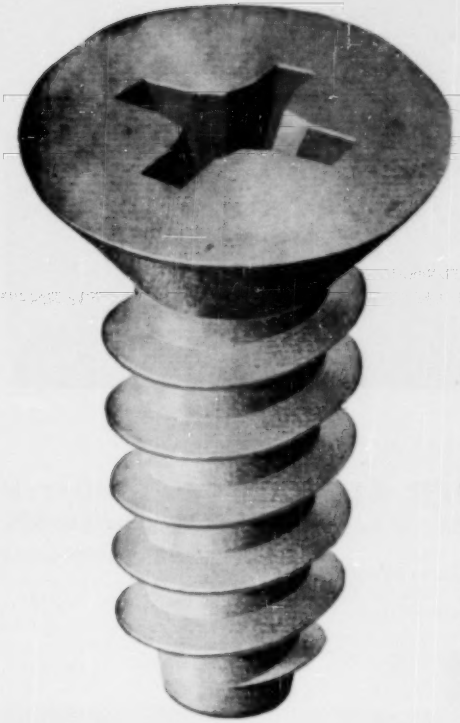

Two good ideas are better than one!

The N.P.K. hardened self-tapping screw—which cuts its own thread in drilled, formed or moulded holes is a good idea. So is the Phillips recessed head which provides a secure grip for the driver, saves time and avoids accidents and damage. Combine the two and you get results like those achieved by one large user. In addition to the time saved in assembly work—2.5 seconds per screw—there were other considerable savings such as the time previously spent in removing and replacing broken screws and regrinding driver 'bits'. Last but not least, the operators had more confidence in driving Phillips Head type screws and avoided the numerous accidents previously caused by slotted heads.

FULL TECHNICAL DATA REGARDING Nettlefolds Parker-Kalon Self-tapping Screws and Phillips' Recessed Heads are available on request from :—

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Models are available up to 100 kc at power outputs of up to 5 watts.

These instruments are distinguished for their superb engineering and individual accuracy.

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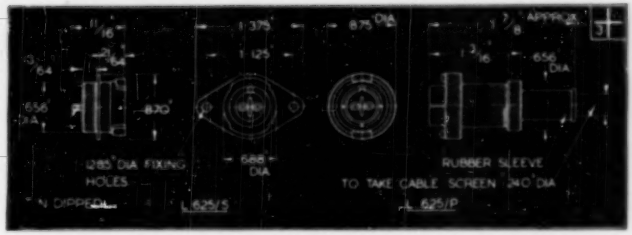
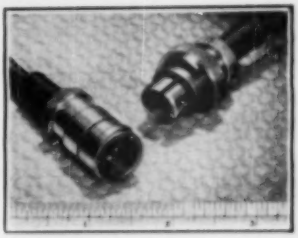
The "Belling-Lee" page for Engineers



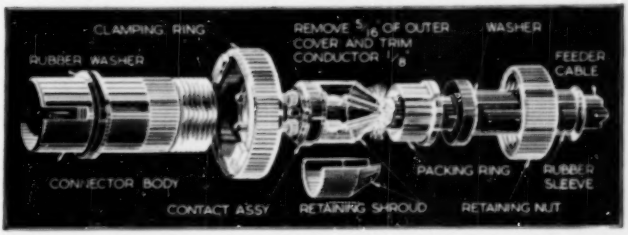


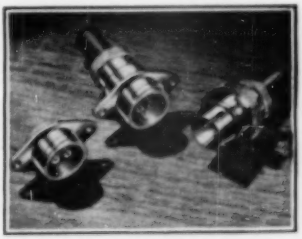
"SCREENECTORS"

This new range of screened connectors in light alloy is based upon the draft R.E.C.M.F. specification for a non reversible screened plug and socket to load cables up to 0.24in. diameter over the braid.

Single or multipole contacts may be assembled into the common housings which are designed so that various applications may be employed, e.g. line connector, flex plug and chassis socket and vice versa, through chassis (bulkhead) connector, each part interchangeable in its appropriate position in the assembly.

METHOD OF LOADING IS SHOWN BELOW





Assembly	Coaxial	2-pole	3-pole
Flex plug	L722/P	L625/P	L715/P
Chassis socket	L722/S	L625/S	L715/S
Through chassis socket	L723	L689	L716
Flex socket	L724	L690	L717

Type	Characteristic impedance ohms *	Contact Resistance	Capacitance * Conductor-conductor	Capacitance * Conductor-screen
Coaxial	75	Less than 1 milliohms each	—	—
2-pole	100		1 pF	2.5 pF
3-pole	—		—	—

* At 1 Mc/s

Other design features include: (1) High grade bakelite insulators (2) Simple assembly and loading. (3) Positive quick action locking device. (4) Machined light alloy screened housing finished for instrument panel requirements.

Some of the characteristics of these connectors are shown opposite.

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For efficiency and fidelity each Rola speaker is indeed "one in a million" but in a more literal sense, every Rola you receive is one in ten million speakers which are proving the superiority of Rola perforance throughout the world. So let figures speak for themselves and specify Rola.

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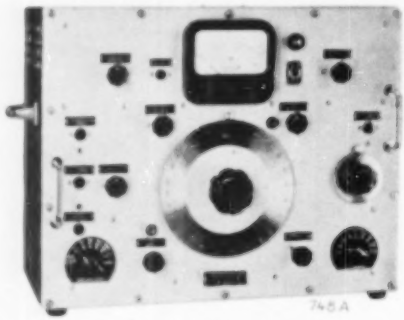
ROLA *The Speaker You Know by Ear*



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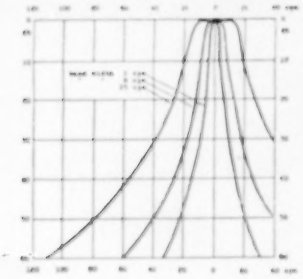
TYPE FRA1 **WAVE ANALYZER**

with adjustable bandwidth. Selectivity adjustable to 2, 8 and 25 cycles " flat top " bandwidth. The response is shown in the curves below. Frequency range 20 to 16,000 cycles. Scale length 520 mm. Full scale sensitivity 100 microvolts, adjustable in 14 steps of 10 db. Scale reading in millivolts and db. Maximum input voltage permissible : 400 volts Lowest voltage measurable : 2 to 4 microvolts. Hum voltage components 10 to 15 microvolts.



typical response curves

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CAPACITORS

THIS modern method of mounting Dubilier Drilitic Capacitors enables the maximum advantage to be secured from the improved electrical characteristics and size reductions, and is one instance of modern capacitor engineering.

No loose parts, clamps, screws or rivets are necessary—a slight twist of the mounting ears and the capacitor is fixed. For chassis capacitor isolation, bakelite mounting plates are supplied; metal plates are available with identical centres for general replacement purposes of the older type capacitors and for interim tooling period.

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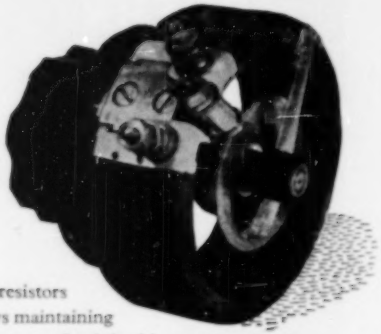
Phone: Acorn 2241 (5 lines). Cables: Hivoltcon, London. Marconi International Code. Grams: Hivoltcon, Westphone, London

D48A



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Our experience in the manufacture of toroidal-wound resistors goes back such a long way that we are confident of always maintaining the lead in design and efficiency. As the pioneers of this type of unit in this country, we can offer our customers a product which is the result of long research and practical experience, and we are also able to supply more alternative arrangements than any of our competitors.

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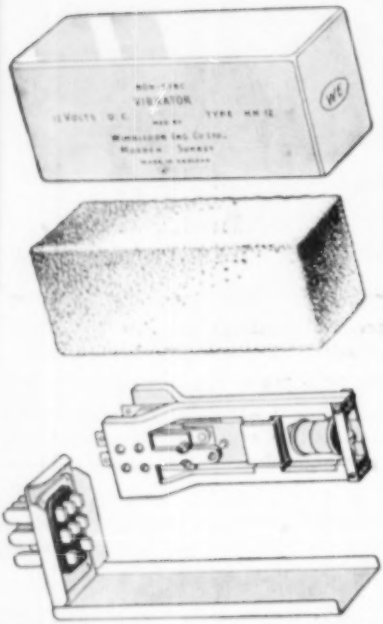

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1. Carefully designed and tested.
2. Made throughout from selected high grade materials.
3. Will give satisfactory service over a long period.
4. Reliable in operation under rated conditions of use.

Available in both SYNCHRONOUS and NON-SYNCHRONOUS Types; POWER UNITS to suit.

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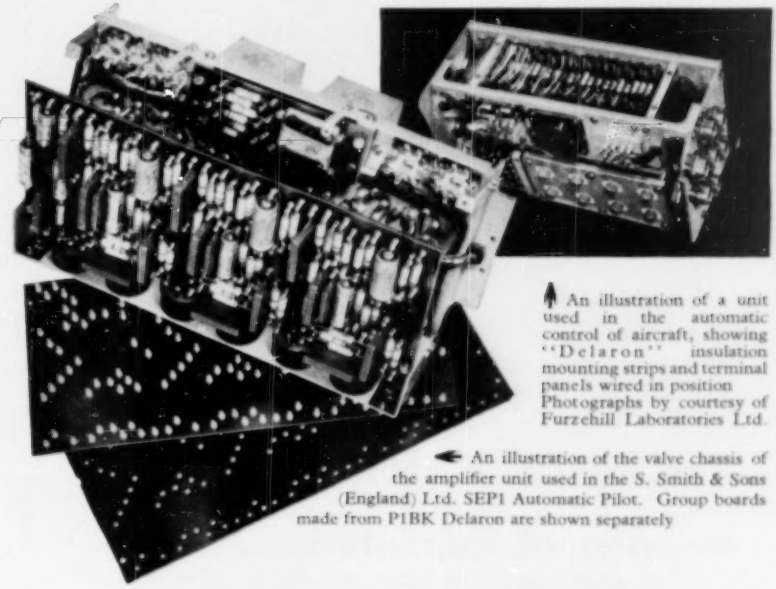

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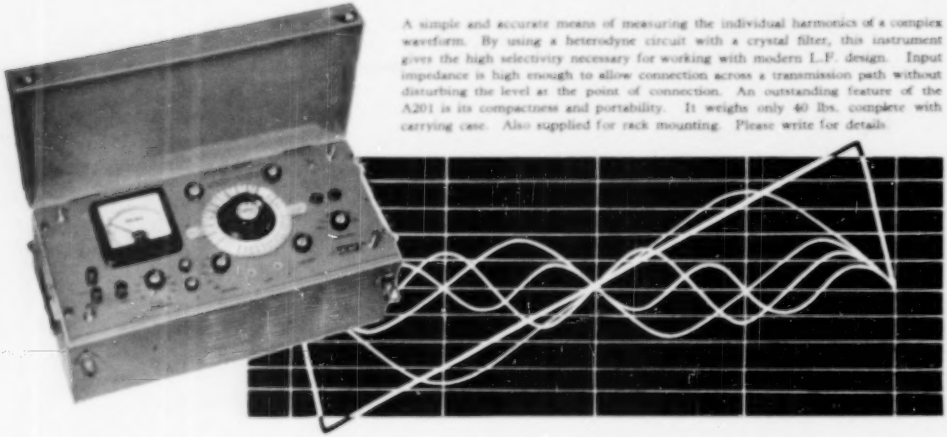

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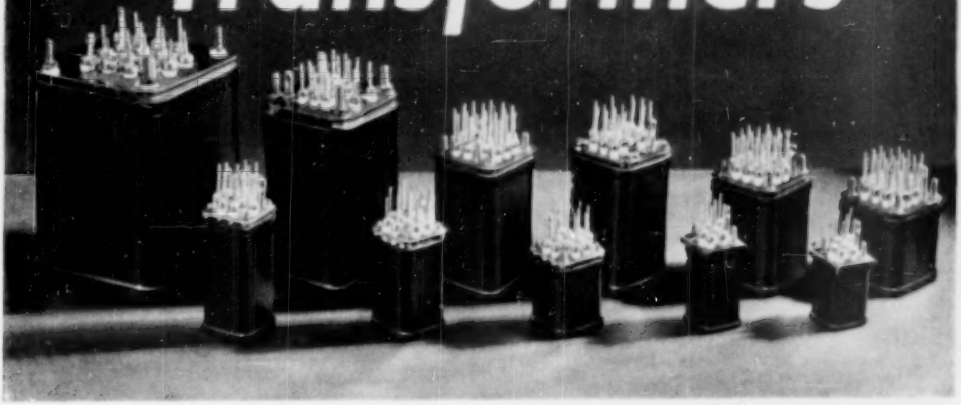

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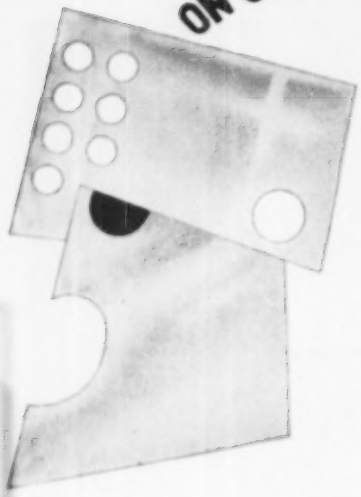

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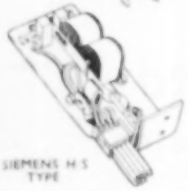

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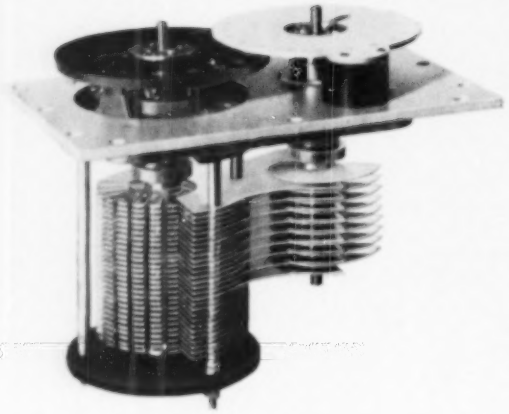

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OCTOBER / NOVEMBER 1950

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Published on the sixth of each month

Annual Subscription : Home and Overseas, one year £1 12s. 0d., six months 15s. : U.S.A. and Canada $5.50

Editorial, Advertising and Publishing Offices

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WIRELESS ENGINEER

Vol. XXVII OCTOBER/NOVEMBER 1950 No. 325-6

Action and Reaction

IN this article we discuss a problem which arose in the discussion following a recent lecture at Birmingham. There are really two distinct problems, both concerned with a homopolar motor. In Fig. 1 the armature consists of an iron cylinder covered with an outer cylinder of copper; at one end there are a number of brushes connected to the positive supply terminal and at the other end a number of brushes connected to the negative supply terminal, so that the armature current is approximately a uniform axial current. The magnet system is cylindrically symmetrical, the field coils being situated at each end as shown. The copper cylinder is situated in an approximately uniform radial field, and will experience a circumferential torque. The armature supply leads are brought out through radial holes in the magnet shell.

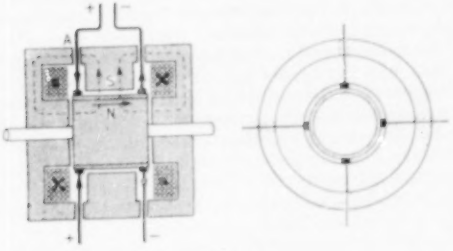


Fig. 1.

The first question is relatively simple; since the magnet system exerts a torque on the armature, there must be an equal and opposite torque exerted on the field system; where and how does this take place? Fig. 2 is an enlarged diagram of a small portion of the copper cylinder and air-gap, showing the path of a line of force. In the iron of the armature it is radial, but on passing through the current-carrying copper it is curved due to the increasing tangential H; in the air-gap the tangential H is approximately constant and the path therefore straight, but on entering the iron, the tangential B is greatly increased and the line of force is refracted as shown. As is now well known,* no tangential mechanical force is exerted on the iron by this refraction of the magnetic flux at its surface. Hence the magnetic flux in the polar ring has a circumferential component, which it loses, however, on passing the leads carrying the current to the armature. We have drawn one set of leads in such a way as to bring out the fact that all these leads and the copper cylinder constitute a solenoid, outside of which there is no circumferential field. Fig. 3 indicates how the current passing through the hole A in Fig. 1 modifies the field so as to remove its circumferential component. The concentrated field on the one side of the hole exerts a transverse Maxwellian pressure on the interface between air and iron, so that the force is not exerted on the conductor but on the iron. This,

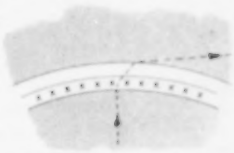


Fig. 2.

Fig. 3.

Electrician, 1945. Vol. 114, p. 763.

then, is the answer to our first question; the reaction to the force exerted on the copper cylinder acts on the walls of the holes carrying the armature supply leads.

The second question is of an entirely different character. The axial current in the copper cylinder consists of the movement of free electrons, and due to their axial movement in the magnetic field these free electrons experience a force normal to the field; that is, circumferential with a small inward component. The latter will tend to give the cylinder a negative charge on the inside and a positive charge on the outside, but we are more interested in the circumferential force on the free electrons.

Our second question is this. How are the circumferential force and consequent torque transmitted from the electrons to the atomic structure of the metal? In the ordinary armature conductor the movement of the electrons is limited and a very small movement causes large electrostatic forces, but in this cylinder the circumferential movement is quite unlimited, so far as the geometry of the conductor is concerned. The most probable explanation appears to be that each axially moving electron is accelerated circumferentially and thus follows a spiral path until it collides with an atom. The torque will then be due to the bombardment of the atoms by the myriads of spirally moving electrons. The only alternative explanation is that, although the so-called free electrons are free to move from atom to atom in the direction of an applied electric field, they are not free to move at right angles to this path but are constrained by electrostatic forces between them and the atoms. If, instead of copper, we assume the armature cylinder to be made of a perfect conductor, the explanation of the torque becomes even more difficult.

G. W. O. H.

Sommerfeld's Surface Wave

In 1909 Sommerfeld published a mathematical article of seventy pages in which he showed that, when a dipole radiates electromagnetic waves over a plane earth, in addition to the radiation into space, there is a surface wave; that is, a wave attached to the surface, and therefore radiating cylindrically rather than spherically. This tends to conserve its energy near the earth's surface, but on the other hand it is subjected to attenuation due to losses in the earth's surface. Although only solved for a plane earth, it was thought that this surface wave was effective in transmitting the waves around the earth's curvature. Zenneck was associated with Sommerfeld in his original work on the subject, and the wave is sometimes referred to as Zenneck's surface wave. The existence of this surface wave was based on the solution of a complex differential equation, and in 1919 Weyl raised doubts as to the correctness of Sommerfeld's solution. In 1935 Norton gave a solution which contained no surface wave, and in 1937 and 1948 Burrows published experimental results which agreed with Weyl and Norton and disagreed so greatly with Sommerfeld as to show beyond doubt that the surface wave was based on some error. In 1937 both Wise and Rice gave solutions of the problem which did not contain a surface wave.

In the *Proceedings of the I.R.E.* for July there is an article by two scientists working in Paris, T. Kahan and G. Eckart, who have gone into the matter very thoroughly and have discovered that, in carrying out his integration, Sommerfeld neglected a factor which just cancels out the surface wave. The surface wave of Sommerfeld and Zenneck is therefore non-existent.

G. W. O. H.

On account of the recent dispute in the printing trade we regret that it has not been possible to publish *Wireless Engineer* on its normal dates. This issue, which is dated October/November, has been expanded to include double the normal number of Abstracts and Reference pages; it includes abstracts which would have normally appeared in the September and October issues.

INTERFERENCE EFFECTS IN PULSE-WIDTH MODULATION

Television Sync-Pulse Sound System

By W. E. Ingham, B.Sc., (Eng)., M.I.R.E., Grad. I.E.E.

(*E.M.I. Research Laboratories Ltd.*)

SUMMARY.—This article describes the results of an investigation designed to determine the effects of ignition interference on a width-modulated sync-pulse method of transmitting television sound.

Emphasis is laid on the importance of considering interference levels which correspond to those normally encountered in practice, and in an experimental study, of using interference inputs having the same character as actual impulsive fields. Great importance is also attached to the choice of the method of measuring the level of the noise output, in order that the result shall agree with the 'loudness impression,' given to the listener, of the noise from the loudspeaker. This article therefore contains details of a suitable subjective method of measurement, and shows how this was developed from a similar method which proved inadequate because it gave only one 'figure of merit' to represent the performance of the system. The method may be used to check the performance of any modulation system.

A limited number of objective noise readings were taken, and from a somewhat brief comparison of these results it appears that r.m.s. output-noise measurements are in agreement with the subjective ones. It seems that, with certain limitations, these objective readings are valid, and should certainly be used in preference to peak value readings.

The results are given of measurements made to show how the noise output is affected by changes in the synchronizing-pulse demodulator. Thus the performance to be expected from any particular circuit may be estimated, and the optimum result obtained. Graphs are also drawn to compare the modulated-synchronizing-pulse system with amplitude and frequency modulation over all interference levels likely to be encountered in normal use.

1. Introduction

1.1 *W.M. Sync-Pulse Sound*

BEFORE dealing with the effects of impulsive interference it is necessary briefly to describe the method of transmitting a television sound signal by width modulating the synchronizing pulses contained in the vision signal. For brevity, the method is here termed 'w.m. sync-pulse sound,' and a detailed description has been given by E. L. C. White.[1]

The sound programme associated with the television picture is transmitted on the same carrier as the vision signal by width modulating the line synchronizing pulses. In common with other pulse-modulation systems, the upper frequency limit of the a.f. modulation is restricted to approximately one-half of the pulse-repetition frequency. It is considered that, with the standard 405-line television signal, this results in a loss of quality that is too great for normal broadcast programme purposes. However, with a 605-line 50 frames/sec interlaced signal, in which the pulse-repetition frequency is 15,125 c/s, the frequency range of the a.f. signal may extend up to about 7 kc/s. Preliminary investigations showed that reasonably satisfactory sound quality could then be obtained.

In a pulse-width modulation system the time duration of the pulse is varied, either increased or decreased, according to the instantaneous amplitude (positive or negative) of the a.f. modulation.

In this system of line sync-pulse modulation the leading edge of the pulse is unaltered and the position of the trailing edge is varied. This enables the leading edge to be used to synchronize the line time base of the receiver in the usual manner. In the waveform illustrated in Fig 1, the unmodulated synchronizing pulses are of 5 μsec duration, the width being varied between 7 μsec and 3 μsec on 100% modulation.

At the receiver the synchronizing pulses may be separated from the vision signal by the usual sync separator. These mixed pulses then contain

(a) The required audio modulation frequencies,

(b) Components of the line sync-pulse waveform,

(c) Components of the frame sync-pulse waveform,

(d) Sum and difference frequencies.

It is, therefore, necessary to separate the line synchronizing pulses, carrying the wanted modulation, from the unwanted frame pulses. The line synchronizing pulses are carried on through the frame synchronizing period, so this separation may be accomplished by a gate[1] designed to pass only the required line synchronizing pulses. A low-pass 'receiving filter' will then remove the

MS accepted by Editor, February 1950

unwanted line-pulse components in the usual way, leaving only the desired a.f. signal.

At high carrier frequencies, the interference produced by impulsive noise fields is one of the most important factors in determining the reliable service range of a given transmitter (except in country districts where the limiting factor may be random noise). It was therefore necessary to investigate the performance of this modulation system in respect of impulsive noise.

The experimental data obtained is recorded here in chronological order, as it is then possible to show how the final method of measurement was developed. Brief reference is made to the results as they occur, but as they are best considered in relation to one another, detailed analysis is postponed to the end (Section 4).

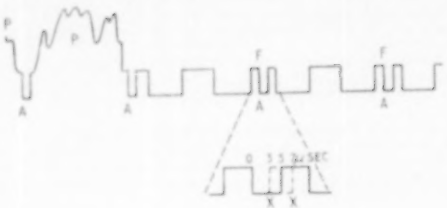


Fig. 1. Vision waveform for width-modulated sync-pulse sound. A = line-synchronizing edge; XX = limits of modulation; P = picture signal; FF = frame synchronizing pulses.

1.2 *Characteristics of Interference*

The various types of 'interference' may be classified under three main headings, namely

(a) Signals from unwanted transmitters,

(b) Random fluctuation noise,

(c) Impulsive interference.

This paper is concerned with the last, but as types (a) and (b) were inevitably encountered, their effects are recorded in brief.

Impulsive interference is the type of interference generated by motor-car ignition systems, electric-traction systems, certain domestic appliances and other devices in which sudden changes of current may occur. Probably the most common source of such interference in television reception is the motor car.

Various estimates of the radiation field, by Eaglesfield[2] and others, suggest that the impulse is of very short duration (10^{-9} sec). It is also suggested that each nominal spark gives rise to a train composed of a varying number of impulses, and being of variable length[2, 6, 8], up to 1.5 msec. The impulses vary in amplitude in a random manner,[9] particularly in an ignition system using a number of spark gaps, and it has been shown[11] that commutator interference is of a similar structure and has a similar random nature.

As the impulses are of such very short duration, they are modified by the relatively small bandwidths existing in the receiver. It has been shown that, provided the impulses appear as separate transients, their output amplitude is proportional, and their duration is inversely proportional, to the bandwidth[5, 6, 12].

The complex nature of the interference field makes it undesirable to use a simplified impulse generator in an experimental investigation of this type. Relatively long impulses of constant amplitude, for example, should be avoided[16]. They are particularly unsuitable in a system such as this in which the operation of the demodulator may change as the noise input level is varied, as they would tend to show a rapid transition of noise output from one level to another which would not, in fact, occur in actual use. It has also been shown[2] that a spark gap associated with a relatively non-inductive circuit tends to produce a single impulse in place of the normal impulsive train. It is also known that a circuit consisting of an induction coil and a single spark plug, radiates impulses which, though still of random amplitude, vary much less in amplitude than do those from an actual multi-plug motor-car circuit.

Therefore, in order to ensure that results representing the actual performance of the gating and limiting circuits should be obtained, a four-cylinder car-ignition system was used to generate the interference.

1.3 *Consideration of the Method to be used.*

A small transmitter was constructed and provision was made to enable the carrier to be frequency-modulated by the sound signal, or to be amplitude-modulated by either the actual sound signal or a 605-line sync-pulse television signal, in which the line sync-pulses were width-modulated by the sound signal.

The output of the transmitter was mixed with the noise signal, and the combined signal and interference applied to the inputs of two receivers. The first was a communication-type of superheterodyne, which could be switched to receive either amplitude modulation or frequency modulation, and the second was a normal television receiver. The a.f. output from each detector was taken to a common a.f. amplifier (provision being made to reduce the frequency range of the latter by a low-pass filter), and thence to a loudspeaker.

The procedure envisaged was that the gain of each receiver should be adjusted so that, with a given transmitter power and 100% modulation, the a.f. output would be equal

to some predetermined figure which was representative of a normal listening level. The interference signal was then to be applied, and the output noise level noted.

However, as the character of the sound produced by the interference varies with the type of modulation in use, it was first of all necessary to decide on the method to be used to measure the noise output. It was essential that the method should give a result in agreement with the loudness impression of the complex noise sound to the listener.

From published work, it would appear that although many practical and theoretical investigations have been performed in order to determine the effect of various circuit parameters on the shape and magnitude of the output noise impulse, the interpretation of this complex output in terms of true annoyance value has not always met with the attention it deserves. It should be remembered that the final judgment on the noise level rests, in practice, with the listener. Therefore, the measuring device must measure the peak value, the r.m.s. value, or whatever value corresponds to the true 'annoyance value'—if indeed any such single value is found to be adequate. Thus, a meter whose reading does not represent the loudness correctly may possibly be suitable for obtaining relative readings representing intensities of the same noise, but would give quite misleading readings when called upon to compare the loudness of two different types of noise. This does not necessarily mean that such a meter would even be satisfactory for use with one type of modulation system. For example, it is shown in a paper by Bradley and Smith [14] that on frequency modulation the output noise character may change with a change in level of the interfering field. The interference produces 'clicks' in some instances, and 'pops' (which are far more disturbing) at other times, an effect which is very noticeable in practice.

A further difficulty is that at high ratios of input signal to interference, the meter readings obtained on 'background noise' alone (including hum, random noise, imperfect frame-pulse separation) are no longer negligible compared with the noise to be measured. A meter is then unable to distinguish the significant from the unwanted noise, and gives an incorrect reading. Neither is it possible to use a meter to measure the noise in the presence of a.f. modulation, unless a very high (or low) frequency is used for the latter.

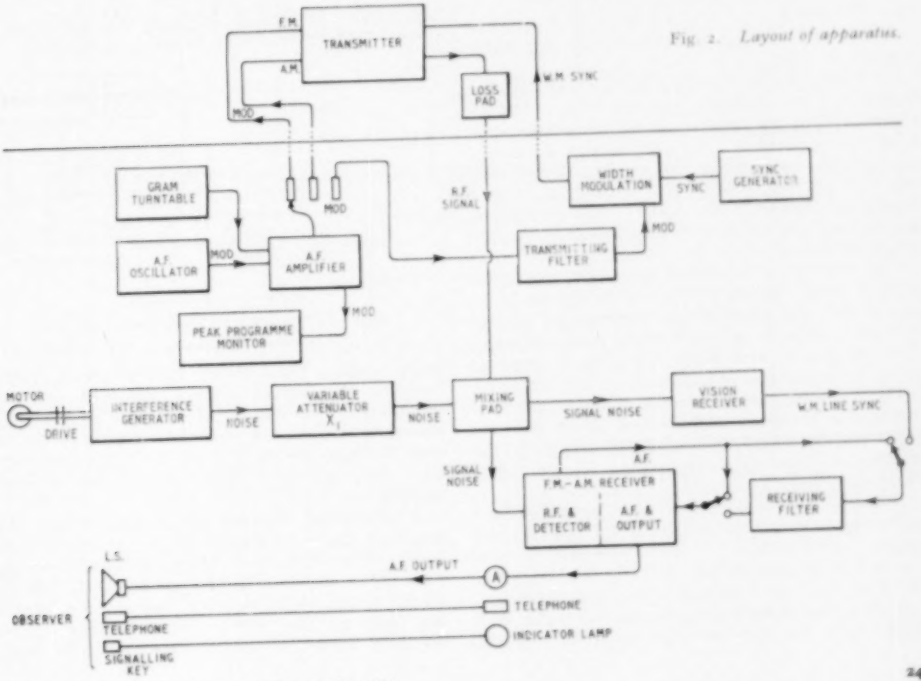


Fig. 2. *Layout of apparatus.*

It was therefore decided that, rather than attempt to determine the correct objective method of measuring the psychological effect of the noise, a subjective method of measurement should be used in these tests. Some readings were, however, taken *using instruments*, and although these were not made with the object of fully investigating the problem, they appear to indicate that the r.m.s. value of the noise output is more nearly in agreement with the true loudness level than the peak or mean values. Although the r.m.s. value has previously been used for estimating the level of fluctuation noise, it has not been accepted for use with impulsive noise.

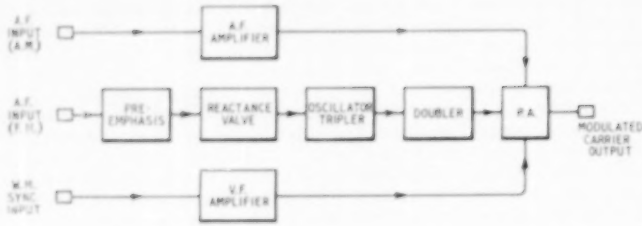
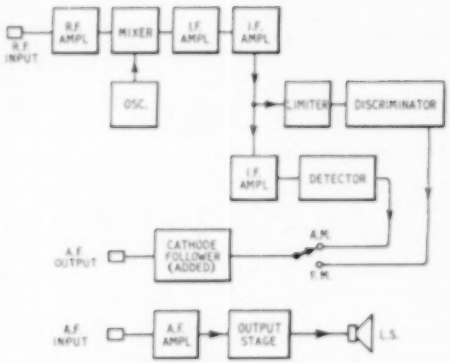


Fig. 3 (left). *Block diagram of transmitter.*

Fig. 4 (below). *Block diagram of a.m.-f.m. receiver.*



2. Initial Tests

2.1 *Apparatus*

A diagram showing the layout of the apparatus is given in Fig. 2.

The interference generator, formed of the four-plug car-ignition circuit, was housed together with its large capacity accumulator in a heavy copper box. The output was developed across a 10-ohm resistor in the plug circuit, and was brought out to the attenuator via a short length of lead-covered cable. The distributor was driven by a small induction motor at a speed giving about 93 sparks per second.

The attenuator was used to control the interference level, frequent checks being made to ensure that the level of the interference voltage obtained at any given setting was constant. The attenuator was made up from a screened piston-type variable capacitance (4.5 pF to 0.1 pF).

Fig. 3 shows a block diagram of the transmitter which was screened and located about 100 feet from the receivers in order to minimize the pick-up of stray radiation fields. The operating frequency was 45 Mc/s.

A carrier power of 4 watts was used on f.m., with a maximum deviation of $\pm$ 75 kc/s, and 50-μsec pre-emphasis. Anode modulation of the final stage provided an a.m. signal, the power being as for f.m. There was no pre-emphasis.

It was also possible to grid-modulate the final stage with the 605-line vision signal, the r.f. power output being 4 watts at 'black level.' There was no picture present. Fig. 2 shows that the a.f. modulation was applied to the line-synchronizing pulse-width modulator through the transmitting filter. This was a low-pass filter designed to pass frequencies below 6,100 c/s, and is necessary with this type of modulation system in order to prevent unwanted frequency components appearing in the output.

The 'communication receiver' used for the reception of a.m. and f.m. (Fig. 4), employed coupled tuned circuits to give an i.f. bandwidth of 2 $\times$ 97 kc/s (6-db points) on f.m., and 2 $\times$ 17 kc/s when switched to a.m. A 50-μsec de-emphasis circuit was included on f.m. but not on a.m., the overall audio-frequency response extending to 15 kc/s on the former and 10 kc/s on the latter system. The performance of the f.m. limiter stage was known to be not outstandingly good. These brief figures are included because the actual results obtained on any modulation system depend to some extent on the characteristics of the receivers employed. However, as these are thought to be fairly representative, they are used here for purposes of comparison.

A television receiver of normal design was used for pulse reception (Fig. 5), the circuits being adjusted to give single-sideband working with an i.f. bandwidth of approximately 3 Mc/s. In the initial experiments a simple demodulator was added, the mixed synchronizing pulses obtained from the normal sync separator being

applied to a line-synchronizing pulse 'gate' of the coincidence type, employing a double-triode valve with a common anode load as shown in Fig. 6. A gating pulse was taken from the screen

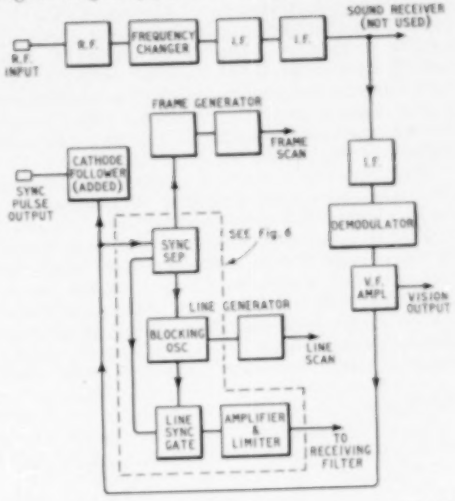
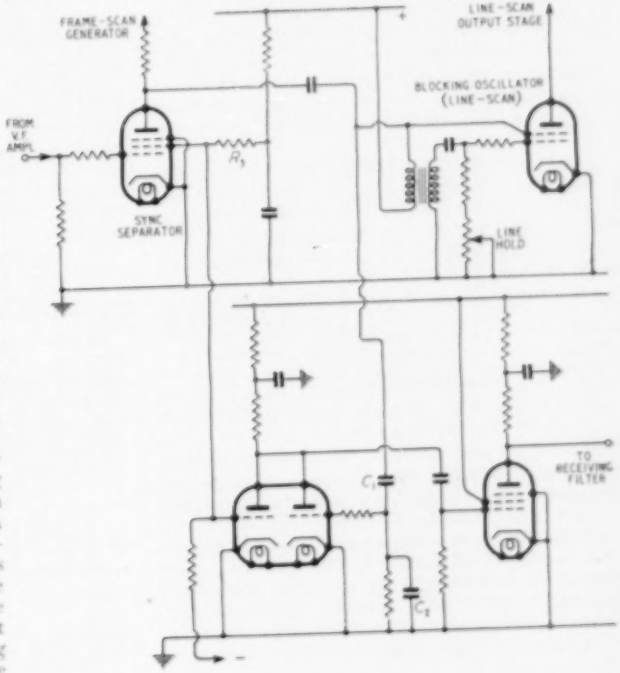


Fig. 5 (above). *Block diagram of vision receiver (with modifications.)*

Fig. 6 (right). *W.M. sync-pulse gate (see Fig. 5).*



of the valve used as a line oscillator and was applied through the capacitance potential divider C_1C_2 to the second grid of the double triode. This pulse, illustrated in Fig. 7(a), was limited by grid current and by anode current cut off, so that a slice of the pulse was used, as shown. The waveform of this pulse will be seen to be very suitable as it was of approximately the correct duration. With the circuit used there was a time delay of about 1.5 μsec between the leading edge of the synchronizing pulse and the gating pulse when adjusted by 'line hold' to be a minimum. Such a delay introduces no audio distortion unless it is large enough to reduce the excursion of the modulated edge of the synchronizing pulse at full modulation. The trailing edge of the gate must accept the fully-modulated (7 μsec) pulse and reject the following frame pulse.

Fig. 7(b) shows the waveform of the output of the double-triode stage, and it is such that it was possible to separate the modulated pulses on an amplitude basis in the following amplifier. The output was finally applied to a low-pass filter to remove all frequency components other than the wanted modulation.

When this receiver was used in the presence of noise it became apparent that the performance of the w.m. sync system was very unlike that of the a.m. and f.m. systems, and that it would be necessary to repeat the readings with a demodulator which would allow a more detailed investigation to be made.

A more flexible circuit was therefore constructed in addition, in order to allow the various circuit parameters to be varied independently. A cathode follower was added to the receiver (Fig. 5) to supply the complete synchronizing pulses to the new demodulator chassis (Fig. 8).

This was connected to replace that part of the circuit shown (Fig. 2) between the vision receiver and the audio output stage. The synchronizing pulses were amplified and applied to a window circuit consisting of a pair of valves with a

common cathode circuit of relatively high impedance,[11] by which it was possible to select a 'slice' of about one fifteenth of the amplitude of the synchronizing pulse at any position from top to bottom of the pulse. The slice was then applied to a gate circuit consisting of a similar pair of valves, so that when the gate was closed it was impossible for any input voltage to appear at the output.

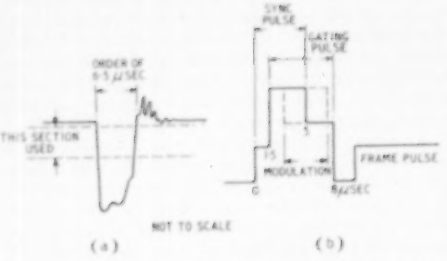


Fig. 7. (a) *Gating pulse from line oscillator*; (b) *waveform of the output from the pulse separator.*

By selection on S_{1a} and S_{1b} the gating pulse could be obtained

(i) From the receiver line oscillator as previously explained, Fig. 7 (a).

(ii) From a multivibrator triggered by the line oscillator.

(iii) From the multivibrator triggered by a pulse derived directly, over a separate line, from the synchronizing-pulse generator at the transmitter.

This pulse generator was designed to provide a trigger pulse, the timing of which could be continuously varied (either advanced or delayed) with respect to the line-synchronizing pulses. This enabled the position of the gating pulse to be moved [see (iii) above].

The gate width could be altered (by means of the multivibrator) so that there was complete control of the gating conditions.

Switch S_2 (Fig 8) selected either

(i) W.M. sync-pulse sound.

(ii) f.m. or a.m. with the receiving filter to limit the audio range.

or (iii) f.m. or a.m. without the receiving filter.

By means of S_3 it was possible to include an amplifier stage with a weighted frequency characteristic (see Section 3.1).

The loudspeaker employed in the subjective tests consisted of either a loudspeaker combination of two moving-coil units for the lower frequencies and a ribbon speaker (horn loaded) for the higher frequencies, or of a single moving-coil speaker of wide range.

2.2. Experimental Procedure.

The transmitter output was set up to the level given in Section 2.1, and, on 100% modulation, the gain of the receiver was adjusted to give a fixed output current (on ammeter A, Fig. 2) from the a.f. amplifier. As the attenuators and mixing pads were adjusted so that the gain setting and audio output were normal, this procedure ensured that the receivers were operated under representative conditions. The interference was then applied to the unmodulated carrier through the attenuator X_1.

The interference input level was then reduced until an observer, listening near the loudspeaker, signalled that the noise output was no longer audible. A similar observation was then made by increasing the interference level, and to improve the accuracy many readings were taken by different observers. Thus for each system under test a reading of the attenuator was obtained, which was a capacitance representing the interference level required, with that

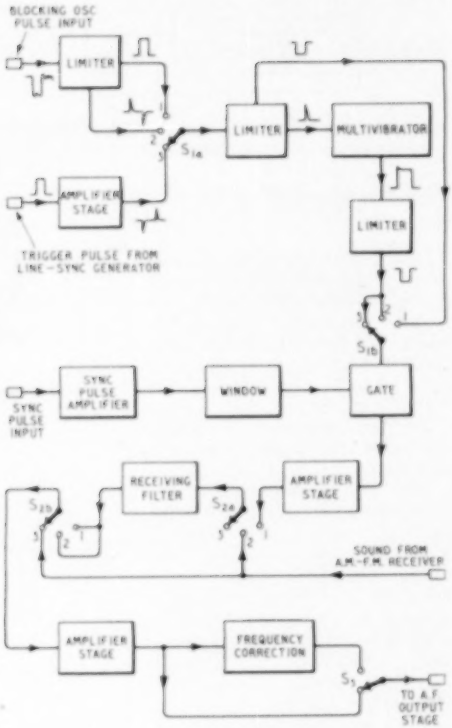


Fig. 8. *Block diagram of experimental w.m. sync-pulse demodulator (showing waveforms).*

system of modulation, to give a noise output which was just audible.

2.3. *Results and Limitations of the Method.*

It was originally intended that such a reading should be taken to indicate the performance of each method of modulation in respect of impulsive noise. However, the known non-linear relationship existing between the input and output noise levels proved to be so noticeable over the range of interference levels normally encountered, that this scheme had to be abandoned.

If any single 'figure of merit' is used to represent the performance of a modulation system it is likely to be very misleading, as it may only illustrate the performance correctly at one certain input level. In particular, the readings mentioned above have the additional disadvantage that they refer to the input noise levels. If one system is said to be x db better than another, a comparison of noise outputs is suggested, but with the above readings it would really represent a ratio of interference inputs for a given noise output, which may evidently be quite a different thing.

The readings are therefore not given here in detail, but will be considered in general so far as they illustrate the effects mentioned above.

It was found that, when the simple pulse demodulator (Fig. 6) was used in the initial readings, although the a.m. reading was approximately 20 db higher than that for f.m., very similar attenuator settings were recorded for a.m. and w.m. sync sound (without modulation). These results would therefore have given the impression that the performances were similar in respect of impulsive noise. However it was apparent that whereas the noise appeared gradually on a.m. as the interference input was increased, it appeared suddenly on sync sound when a threshold input was exceeded, so that a further large increase in input was required on a.m. to give an equivalent noise output.

This effect was also shown by the measurements made in the presence of audio modulation. The modulation was chosen so as to mask the noise (a steady tone was found to be quite unsuitable), and to be of approximately constant level. It was then necessary to increase the interference input level in order to make the noise audible over the modulation. The increase required on w.m. sync sound was very small because of the rapid rise of noise output at this point, and was much less than that required on a.m. so that the ratio of noise inputs became about 28 db.

The increase on f.m. was also smaller than a.m. because of the clearly audible increase of noise output occurring when the signal was frequency modulated[14].

The pulse demodulator of Fig. 8 was used in order to show the effect of varying the window position, and as these results helped to complete the picture of the operation of the system (Section 4) they are given below. The gate was triggered by the line-synchronizing pulse generator, the delay being adjusted so that the leading edges of the gate pulses and the sync-pulses were coincident at the gate. The gating pulse was adjusted to be 7 μsec wide so that it would accept a fully modulated sync-pulse, although no audio modulation was present. The readings are shown in graphical form in Fig. 9, each reading being, as before, an average result of the noise input required for the output to be just audible. The interference input levels are plotted in decibels with reference to the level required with

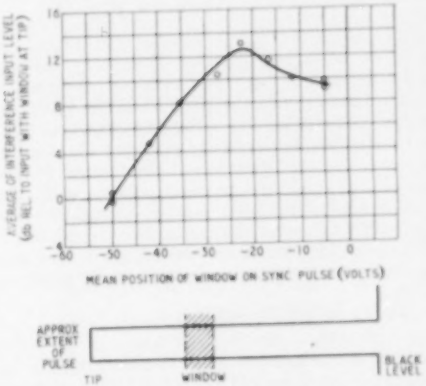


Fig. 9. *Graph of noise input required to give just audible noise output at various window positions.*

the window at the tip (i.e., zero carrier end) of the synchronizing-pulse, (— 50 V, see Fig. 9).

It has been suggested[15] that when a gating circuit is used in connection with a pulse-modulation system, the interference may cause additional noise by affecting the timing of the gate. Readings were taken to check this, by making observations with the gate derived, in turn, directly from the blocking-oscillator pulse (normal), from the multivibrator triggered by the blocking-oscillator, and from the multivibrator when synchronized over a direct line with the line-synchronizing pulse generator (fixed gate). The average results were all within + 1 db and no conclusive evidence could be found of additional noise output due to gate shift at this interference level.

Attempts were made, by reducing the bandwidth of the sync-pulse amplifier of Fig. 8, to decrease the height of the noise impulses so that they no longer cut across the window. The demodulator was set up as for the readings of Fig. 9, and the bandwidth altered first with the window at the centre of the pulse and then when almost at the tip (actually -45 V). The average results are given in Table 1.

TABLE 1

Interference Input v. Bandwidth of the Synchronizing Pulse Circuits.

Bandwidth of sync-pulse amplifier stage	Average result for reading attenuator X_2	
	Window at -27 V	Window at -45 V
Normal	6.3 mpF	2.4 mpF
Reduced to 1.4 Mc/s	8.1 mpF	
Reduced to 0.9 Mc/s	8.9 mpF	2.5 mpF

Other readings either yielded no conclusive result or were repeated in Section 3, so the results are not given. For example, no change in noise reading was obtained when the receiving filter was included on a.m. and f.m. to limit the bandwidth, either in the presence of, or without, modulation. Nor was any change in the w.m. sync reading obtained when, with the window set to the centre of the sync-pulse, the gate width was altered from 4 μsec to 10 μsec.

The relevant results are examined, in conjunction with those of Section 3, later in the paper.

3. More Detailed Tests

3.1 *Improved Subjective Method.*

Attempts to provide more detailed results, by comparing the noise outputs of the three systems at various interference levels with a steady reference tone, failed owing to the widely different character of the sounds. The following subjective method of measurement was therefore devised, in which the layout of the apparatus (as shown in Fig. 2) was modified according to Fig. 10, and the procedure was as follows.

The gain of the receiver under test was adjusted as before, to give a fixed output on a fully modulated signal (1500 c/s). The output to the loudspeaker was then turned on and off at random by means of the fader, and the level gradually reduced by the attenuator X_2. The observer caused the signal lamp L to light whenever he considered he was able to hear the modulation, the reading of X_2 being noted at the point at which the observer was just unable to give consistently correct signals. This figure represented the sound output on 100% modulation.

Similar figures were obtained for the various noise outputs resulting when different interference levels were applied to the unmodulated carriers. Readings were taken by two observers, and the average value calculated. A graph was then plotted to show the law relating interference input to noise output for each modulation system. The position of each of these graphs was fixed with respect to the sound output on full modulation, and therefore the graph of one system can be compared with the graph for any other system.

Any hum output was made inaudible by means of the 200-c/s high-pass filter, frame synchronizing pulses being removed so as to avoid any slight noise due to possible imperfect suppression. A further source of error was removed by means of a frequency-correction network. This was a stage with a frequency response weighted to represent the difference between that of a normal ear at threshold, and at 60 db above threshold. The network had zero gain at 1,500 c/s. When the correction amplifier was in circuit, the noise appeared to the ear to have the same frequency distribution at threshold as at the normal listening level, which was assumed to be 60 db above threshold.

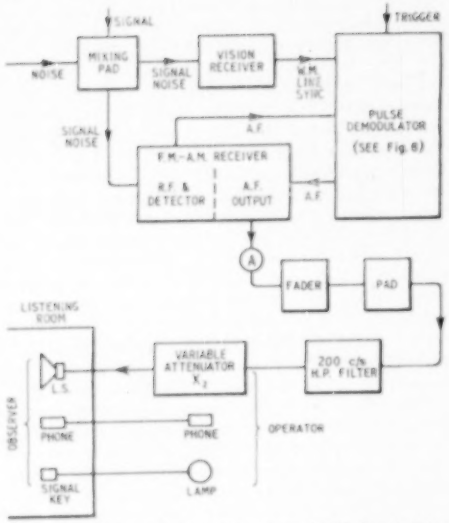


Fig. 10. *Modified layout for more detailed measurements.*

3.2 *Results Obtained by the Improved Method.*

The amplitude and frequency modulation readings are included in Table 2, where it will be noticed that the readings of two observers are recorded in full to illustrate the procedure involved, in subsequent readings only the resulting

graph is given, but it should be remembered that the same method of averages was used throughout. No low-pass receiving filter was used on these runs, and there was no audio modulation present on the signal.

Specimen readings were repeated on separate occasions (by way of a check) for each set of results, although these also are not shown. As the absolute level of the interference input was unknown, the readings were recorded on an arbitrary decibel scale, Fig. 11 showing the results in graphical form.

Similar readings were then taken for w.m. sync sound, the transmitter and receiver being set up as before, and input-output graphs obtained for three different adjustments of the pulse demodulator gate. Condition 'N' (normal) gave the same result as 'F.G.' (fixed gate)—within the limits of measurement. Although the average value tended to be less, the change was not sufficiently large to assess by this method. The threshold input (for Condition 'F.G.') was determined by the earlier subjective method, described in Section 2.2, as the noise output at this input was below random noise level (see Fig. 12). With X_2 set for an output level of 76 db below 100% modulation, the average reading of X_1 was 3.5 mpF, corresponding to 21.5 db on the input scale. These results are plotted on Fig. 12, with a.m. and f.m. recorded for comparison,

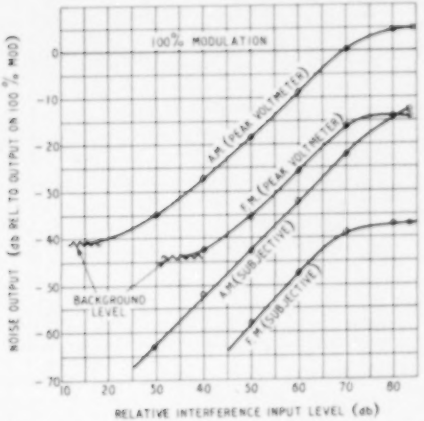


Fig. 11. *Interference input and noise output for a.m. and f.m.*

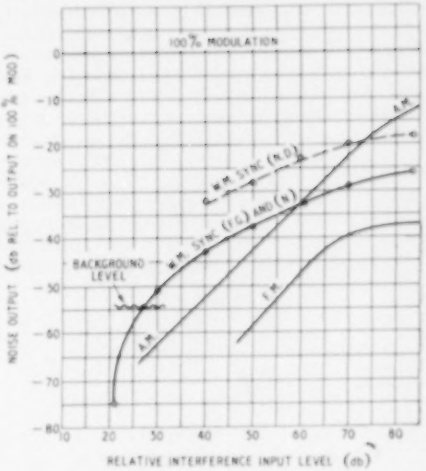


Fig. 12. *Interference input and noise output for w.m. sync sound (f.m. and a.m. for comparison); w.m. sync gate adjustment: F.G. = fixed gate; N = normal; N.D. = Normal, but gate delayed.*

TABLE 2

Noise Output v. Interference Input (A.M. and F.M. readings).

Interference input level		Noise Output							
		Amplitude modulation				Frequency modulation			
X_1 (mpF)	Rel. Level (db)	Attenuator Reading X_2 (db)			Rel. to output on 100% Mod. (db)	Attenuator Reading X_2 (db)			Rel. to output on 100% Mod. (db)
		Obs. A	Obs. B	Average		Obs. A	Obs. B	Average	
4500	83.5	94	92	93	−13	70	68	69	−37
3000	80	92	92	92	−14	70	68	69	−37
1000	70	84	84	84	−22	68	66	67	−29
300	60	74	74	74	−32	60	58	59	−47
100	50	64	62	63	−43	50	46	48	−58
30	40	54	54	54	−52				
10	30	44	42	43	−63				
100% modulation		106	106		0	106	106		0

and they show that with the gate obtained from the blocking oscillator, and the line-hold control incorrectly adjusted—Condition 'N.D.' (normal, delayed)—there was additional noise output due to gate shift.

It may be seen that at the worst input signal to interference ratio considered, the noise output on w.m. sync sound was about midway between the outputs obtained on amplitude and on frequency modulation. Although the sounds were characteristically different—for example the noise on w.m. sync sound appeared much more 'broken' and 'uneven' than the relatively steady note on a.m.—it was generally agreed that this corresponded with the aural impression obtained by switching quickly from one system to another.

The graphs also show that at some interference level the output noises on a.m. and w.m. sync sound will appear equally loud. It was thus possible to make a more precise check by reducing the interference level until an observer, listening normally, signalled that this point had been reached. The comparison was facilitated by arranging for a quick change-over by switching the loudspeaker from one receiver to the other. The readings of the capacitance attenuator X_1 obtained in this way are given in Table 3.

TABLE 3

Interference Input Required for Equal Noise on A.M. and W.M. Sync Sound.

Reading of Capacitance attenuator X_1 (mpF)	
310	
270	RESULT.
330	288 mpF on X_1 corresponds
250	to 59.5 db on the arbitrary
320	(decibel) input scale.
225	
Geometric mean 288	

It will be seen that the average agrees with the point of intersection of the two graphs (Fig. 12).

The way in which the noise output varied with change of the window position was also determined at various levels of input interference. The transmitter and receiver were adjusted as before, the average results being plotted graphically on Fig. 13. The threshold interference input levels were measured as for curve FG (Fig. 12) with X_2 set for an output level of -76 db. Substantially the same input was required with 30 db more a.f. gain showing that a sharp noise cut off was obtained at this input.

The changes in gate width and circuit frequency response previously made in Section 2.3 were repeated, this time with the object of noting the corresponding variation in noise output at high interference levels. The subjective readings, however, failed to reveal any conclusive change of output noise level.

3.3 *Objective Noise Measurements.*

Some of the previous tests were also carried out by making objective readings of the output noise level. In the first instance a peak-reading programme meter having a short charging time constant and long discharge time was used. The audio bandwidth of the meter was greater than that of the receiver, and care was taken to work at a constant low deflection to avoid overloading.

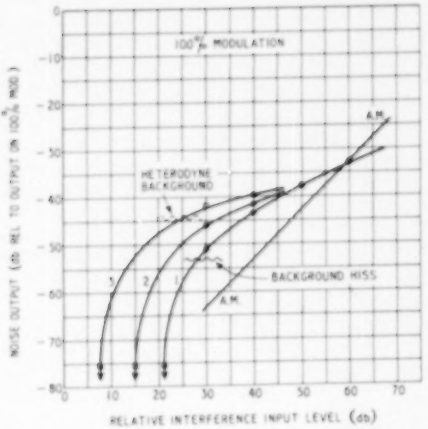


Fig. 13. *Variation of noise output with window position: 1. window at* -28.5 *V; 2. window at* -42 *V; 3. window at* -56 *V; (a.m. for comparison.*

The meter was substituted for the loudspeaker and a constant deflection maintained by means of the attenuator, X_2, the reading of the latter being noted for each interference input level. Readings equivalent to the subjective results of Table 2 are shown on the same graph (Fig 11).

The noise output was also measured by noting the current output delivered by the receiver to a resistive load. The readings were taken at a low signal-to-interference input level, in order to avoid errors due to hum and random noise.

A rectifier meter, reading mean value (calibrated r.m.s.), was used in the first instance, followed by a thermo-type meter to give the r.m.s. value. The a.m. and f.m. readings are given in Table 4 (a), except the current output on f.m., which was not large enough to be measured on the square-law scale of the meter used. Table 4 (a) also gives similar results for the w.m. sync-pulse system, under the three receiver conditions noted in Section 3.2.

As previously mentioned, no detailed attempt was made to determine conclusively the correct objective method of noise measurement. How-

ever, it should be noted that the results of Table 4 do appear to indicate that the r.m.s. value is more nearly in agreement with the subjective results than the peak or mean values. For example, according to the readings obtained using the peak-reading meter, at high interference levels the noise output exceeds the signal output on 100% modulation (Fig 11). A simple listening test showed that this was very far from the impression obtained by ear. Further, the general shape of the input-output graph is not the same as that obtained by subjective measurement. The errors due to 'background noise' at high signal to noise inputs are also shown, and these errors may be expected to be worse when an r.m.s. meter is used.

The noise outputs, obtained at maximum interference input by measurements yielding mean and r.m.s. values, are compared in Table 4(b) with the subjective ratios taken from Fig 12. The mean value readings give the correct answer only when used to compare the levels of noises of a similar character. For example, the readings are correct when comparing various outputs on w.m. sync sound, but not when the noise output for this system is compared with that for amplitude modulation. In the latter instance the noises sounded completely different, and it would appear that the ear rates the annoyance value on a power basis. The readings show that the ratios of the levels, as assessed by the ear, correspond in every case with the ratios of the r.m.s. values of the output currents.

TABLE 4(a)

Noise output—Mean and R.M.S. Value Readings.

Modulation system	Noise output current (mA) at maximum interference input	
	Mean value	R.M.S. value
A.M.	4.1	8.5
F.M.	0.22	—
W.M. sync (F.G.)*	0.45	2.23
W.M. sync (N.)*	0.36	1.7
W.M. sync (N.D.)*	0.91	4.85

* See Fig. 12.

TABLE 4(b)

Comparison of Subjective and Objective Noise Ouput Readings.

Modulation systems compared	Ratio of noise outputs at maximum interference input (nearest db).		
	Mean value readings Table 4(a)	R.M.S. readings Table (4a)	Subjective reading Fig. 12
Amplitude mod / Frequency mod	25	—	24
W.M. Sync (N.D.) / W.M. Sync (F.G.)	6	7	8
W.M. Sync (F.G.) / W.M. Sync (N)	2	2	0
Amplitude mod / W.M. Sync (N.D.)	13	5	5
Amplitude mod / W.M. Sync (F.G.)	19	12	13

On the basis of these results it was felt that it would be correct to use an r.m.s. reading meter to measure those changes of noise output which had proved too small to measure subjectively; for example, inconclusive results were obtained previously when attempts were made to measure aurally the effect of a change of gate width. The tests did show, however, that the noise was always of a similar nature, and therefore accurate results could certainly be expected if r.m.s. meter readings were taken using high interference levels to avoid errors due to background noise.

The thermo-junction meter was used to measure the noise output current. The gate width was then varied over the same range as for the subjective test, the corresponding outputs being recorded in Table 5. The results show that there was no apparent change in noise output until the gate width was reduced so far that it no longer included all the synchronizing-pulse.

TABLE 5

Noise Output v. Gate Width.

Gate width (μsec)	R.M.S. Noise output current (mA)
10	1.5
7	1.5
5	1.5
4	1.25

Although the purpose of the investigation was to determine the performance of w.m. sync sound with regard to impulsive noise, some objective readings were also taken of the random background noise level. No particular effort had been made to design for optimum performance in this direction, so the level may not be taken as necessarily indicative of a representative figure. The results did, however, give a check on the distribution of the noise, and on the reading obtained subjectively during the impulsive noise output measurements (Figs 12, 13).

The readings are recorded in Table 6. A thermo-junction meter was again used, the setting of the attenuator X_2, and the meter reading, being noted for the output on full modulation and on the noise to be measured.

The noise level relative to full modulation was then calculated, and is given to the nearest decibel. Although a high degree of screening was used, beat notes due to r.f. carrier interference were obtained, as the field strength of the unwanted interference was high. This output was also measured and the readings indicate how the effect of such interference may be minimized.

When the thermo-junction was used in the measurements of impulsive noise outputs [Table 4(a)], it was not possible to measure the low f.m. output level. However, because of the extra gain provided for these 'background noise' readings it was now possible to rectify the omission by employing the method used to read the background levels. This result, showing the noise output at maximum interference input, is included at the end of Table 6(F), and is in agreement with the previous subjective reading of Table 2.

3.4 *Impulsive Interference on Vision.*

During this investigation the absolute field strengths of the interference fields were not known, but this was not important in view of the way in which the levels were set up. The fact that the interference input was adjusted experimentally, with normal signal strength and receiver gain, so that all reasonable noise output levels were produced, ensured that practical interference field strengths were investigated. However, in order to relate the performance of the w.m. sync sound channel to the performance on vision, the interference produced on the picture raster was noted at several interference levels. The particular vision receiver in use had no peak limiter or other suppression device.

The brightness control was advanced until the raster was just visible (no picture being present), and the transmitter and receiver gains were adjusted in the usual way. It was observed that the raster suffered heavy interference with X_1 set at 4 500 mμF, producing an interference level of 83.5 db, the white spots then being defocused owing to the large amplitude of the noise impulses. Slight displacement of individual lines could be observed. When the interference level was reduced to the equivalent of 50 db on the input scale the white spots were quite small and relatively few in number, and it is believed that with a picture present they would have been unnoticeable at an interference input level of 34 db.

TABLE 6

Level of Random "Background" Noise on W.M. Sync Sound

	Adjustment of demodulator				Loss at X_2 (db)	R.M.S. Output current (mA)	Noise level relative to 100% mod. (nearest db)	Nature of noise
	Gate trigger	Gate width (μ sec)	Gate position	Window position (see Fig. 9)				
A	From line-sync pulse generator.	7	Delay on gate leading edge very small.	−22.5V	8	4.3	−53	Random hiss.
B	From line-sync pulse generator.	7	Delay on gate leading edge very small.	−50V	18	4.2	−44	Heterodyne beats.
C	From blocking oscillator.	6.5	"Line hold" adjusted for minimum delay.	−22.5V	16	3.9	−46	Random hiss.
D	From line-sync pulse generator.	4	omitting both pulse edges.	−22.5V	0	1.7	−70	Random hiss.
		5	omitting pulse leading edge.		8	4.5	−53	
		5	omitting pulse trailing edge.		8	3.7	−55	
		7	including both pulse edges.		14	3.8	−49	
E	From line-sync pulse generator.	7	Delay on gate leading edge very small.	−22.5V	62	4.1	0	Signal output (100% modulation.)
F	Frequency modulation.				26	3.9	−36	Impulsive interference.

4. Discussion of Results

4.1 *Behaviour of W.M. Sync Sound System.*

The original impression obtained on listening to the noise output as the interference level was increased, was that the noise output appeared abruptly at a particular input—the threshold input, and that above this input there was only a relatively slow increase in output. This was mentioned in connection with the earlier readings (Section 2), and is upheld by the measured performance figures of Fig. 12.

The fact that the input-output graph is non-linear shows how important it is that such an investigation should be performed over a suitable range of input signal-to-interference ratios, and how both theoretical investigations and practical experiments involving objective noise measurements, must be checked to ensure that practical signal-to-noise ratios are considered. The results also show that at all but very high input signal-to-interference ratios, the noise impulses are large compared with the carrier amplitude. This is partly because of the relatively large bandwidth of the synchronizing-pulse circuits, but it does emphasise the fact that a theoretical study considering peak voltages which are, at a maximum, only equal to the signal amplitude, will give an incomplete picture of the operation of the system.

The reason for the appearance of an interference threshold is that, for inputs below this value, the impulses are of insufficient amplitude to reach the part of the synchronizing pulse admitted by the window circuit. They therefore cause no noise output. As their amplitude increases the larger ones break across the window area, and if the interference consisted of uniform rectangular pulses the output would increase no further than that reached when they extended right across the window space. The action with the true noise impulses is similar, so that the noise output does not increase in proportion to the interference input. Fig. 12 shows the sort of rise to be expected.

Depending on the relative amplitude and phase relationships existing at its arrival, a noise transient may either effectively increase or decrease the amplitude of the carrier. Thus, noise impulses may be produced which run either 'inside' or 'outside' the synchronizing pulse, as shown at A and B respectively (Fig. 14). This diagram is drawn assuming positive modulation at the transmitter, as used in these tests. The most important impulses from the point of view of output noise are the larger and more numerous ones shown at A, which arise when the carrier amplitude is increased.

This is illustrated by the readings taken to show the variation in threshold input with change of window position (Fig. 9). They show that the optimum position for the window, though towards the middle of the pulse, is nearer the 'base' (X) than the 'tip' (Y). The readings of noise output (Fig. 13) show that if the window is moved away from the tip, no improvement will result at high or even medium interference levels, because the impulses are large and extend the whole length of the pulse. However, at highest signal-to-noise inputs, when the noise output is of the order of 40 to 50 db down on the modulation, the position of the window is of some importance. Here it was possible, with the circuit in use to reduce the noise by about 10 db when the window was moved away from the tip. The variation in the position of the threshold input was very marked (Fig. 13), an improvement of about 14 db being obtained. This figure is in agreement with the subjective ratio obtained previously (Fig. 9), although the output of the noise generator was modified between these readings so that the actual readings of X_1 were not the same. Fig. 9 also shows how the threshold noise input is lower with the window at the tip than at the base of the pulse. These improvements are useful as w.m. sync sound performs less satisfactorily, in relation to a system in which noise output is proportional to interference input, at these higher input signal-to-noise ratios than at high interference levels.

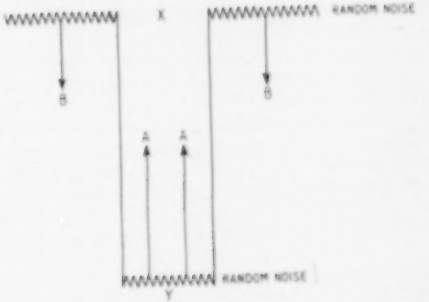


Fig. 14. *Synchronizing pulse with interference.*

The readings taken to show the effect of a variation of gate width also support this noise distribution theory. Although the actual readings are not given, those of Section 2.3 were in agreement with the repeated tests of Section 3.2 in showing that, with the window at the optimum position, any change of output level for gates between 4 and 10 μsec is smaller than can be measured subjectively. The objective readings

of Table 5 confirm this. They show that the output is indeed not reduced until the gate is made small enough to reject a part of the synchronizing pulse. The noise impulses 'outside' the pulse are relatively few in number and are limited to an amplitude which makes them insufficient to affect the noise output. Further, the reduction in noise output obtained by accepting only 4 μsec (or 0.8) of the pulse width is about 1.6 db, which (allowing for error in reading random noise impulses) is in agreement with the 1.9 db predicted by assuming the output to be proportional to the gate width. Thus, if the timing of the gate is delayed by up to 3 μsec compared with the synchronizing pulse, the modulation would not be affected, but the noise may be expected to fall in the ratio 5 : 2 ; i.e., by 8 db.

Such a large delay, although theoretically possible, would be impracticable in normal use, but some improvement may be obtained in this way. It will be noticed that the delay introduced when the blocking oscillator was used ('N' Table 4) reduced the noise output below the level obtained when the whole synchronizing pulse was accepted ('F.G'). The blocking-oscillator anode pulse appears to be very suitable for use as a gating pulse for the following reasons

(i) Using a transformer and circuit of normal design, the pulse is of approximately the correct duration.

(ii) Impulsive interference does not seem to give rise to additional noise output by affecting the gate timing.

(iii) The circuit may be arranged to provide the delay necessary to reduce the impulsive noise output.

(iv) The delay also reduces the random noise.

That the noise output is not normally increased by gate shift (ii) above, was shown by the readings of Section 2.3, and of Section 3.2 (see Fig. 12). Those of Section 2.3 (which it will be remembered were readings of interference input level), were constant (within $\pm$ 1 db), but as these readings were taken at low interference input levels no gate shift would be expected. However, the same result was obtained at very high interference levels when the 'line-hold' control on the receiver was correctly adjusted, so that the normal curve 'N' (Fig. 12) was the same as with a fixed gate ('F.G.', Fig. 12). When however, it was not correctly adjusted, the noise output was increased by as much as 10 db ('N.D.', Fig. 12).

Although, on the above showing, gate shift does not appear to be a likely source of noise, it is worth noting that the line oscillator was triggered from the tip of the synchronizing pulse in the above tests, and that there was no audio modulation present. It would seem that this type of noise may be more likely to occur at high modulation depths, as less shift may then be tolerated before noise output results, although of course the noise would be less noticeable. This idea was not checked but, if required, a further improvement could be obtained by triggering the gate from the output of the window circuit, and by so doing, other unwanted noise levels could be reduced as was shown by 'A' and 'C' in Table 6. These readings show that changing the gate from the line-synchronizing pulse generator of the transmitter (A), to the blocking oscillator of the receiver (C), increased the noise level from 53 db to 46 db below 200% modulation because of the resulting heterodyne beats. The window was unchanged, so that the same portion of the synchronizing pulse was demodulated in C as in A. That this continuous-wave interference was located at the tip of the synchronizing pulse was checked by reading B, in which the gate was fixed as in A, but the window moved to the tip. The noise (heterodyne beats) gradually appeared as the window was moved to the zero carrier end. Thus, had the blocking oscillator been triggered from that part of the pulse seen by the window circuit, the noise would have been removed by the usual correct adjustment.

It appears that no great improvement may be obtained by a reduction of the bandwidth of the stages before the window, although the effect of this experiment was reduced by the rather limited bandwidth of the vision receiver. The subjective readings of Section 3.2 showed no reduction in output noise level at high interference input levels, and remembering how the investigation indicates that the interference impulses are of large amplitude, none would be expected. Readings taken at low noise inputs (Table 1) indicate that some small improvement of the threshold input may be realised by keeping the bandwidth low when the window is at the centre of the synchronizing pulse. The readings also verify that there can be no improvement when the window is at the 'tip' of the pulse, as even small noise impulses will then give rise to a noise output. The degree of improvement possible in this direction is very limited because of the deformation of the synchronizing pulse which is produced, and eventually leads to excessive audio distortion.

In connection with the blocking oscillator it was mentioned that a delay on the gate pulse reduces the random background noise. This results because the noise carried on the unmodulated leading edge of the synchronizing pulse is excluded. Table 6(D) shows the variation in the

level of the background noise produced by excluding the leading and trailing edges of the pulse. With the leading edge just omitted, the noise output was about 53 db below the output on 100% modulation, and this value (which was obtained by objective measurement) is in agreement with that obtained during the normal subjective readings of Fig. 12. Table 6 shows that this is an improvement of about 4 db over the figure realized when both edges were included.

From this picture of the operation of the system under impulsive noise, the performance of a specific circuit may be estimated, by making adjustments to, for example, the graph of Fig. 12 to comply with the particular conditions obtaining.

The use of negative modulation would offer the advantage that it would no longer be necessary to delay the gate by 3 μsec in order to obtain the suggested 8-db noise reduction. The noise impulses marked 'A' (Fig. 14) would then lie outside the synchronizing pulse. On the other hand, the possibility of additional noise due to gate shift would be increased, and the relative magnitude of the 'positive' and 'negative' noise impulses would be altered, necessitating some modification of the optimum window position.

The readings also show the advantage to be obtained by applying blanking or gating pulses to the sound channel in this way, rather than to the vision channel[19].

When a sound signal is superimposed on the vision signal, the two must be separated in the receiver, and this may be done either on an amplitude or on a time basis. If, with a positive-modulation system, it is arranged that the separation shall be done on an amplitude basis the modulated pulse may be made of larger amplitude than the vision signal. The latter will then fail to reach the limiting amplifier in the sound channel, but the interference on the picture signal will reach this level and break through. Interference will then be collected continuously on sound except during the modulated pulse, when the noise may be avoided by suitable window adjustment, although this would now be more difficult. In this arrangement the blanking pulse is applied to the vision circuit in order to prevent the sound signal showing on the picture.

On the other hand if the blanking pulse is used with a suitable gate circuit on the sound channel to separate the sound on a time basis, the noise impulses will be suppressed with the vision signal—except for a very short period of time during each pulse when noise breaks through as explained in connection with the modulated synchronizing-pulse system.

This leads to a very great improvement in the impulsive output signal-to-noise ratio.

4.2 Comparison with Amplitude and Frequency Modulation.

In examining the results, it should be remembered that the transmitter power output was the same throughout the tests on f.m., a.m., (unmodulated carrier) and peak pulse (normal 'black level'). This was considered to be the most convenient condition as there is no universally accepted ratio of vision transmitter power to sound transmitter power, and the results may easily be modified to correspond to any required ratio. In this connection it should be noted that if it is desired to see the effect of such a change, for example on the performance graphs, then whereas the input signal-to-interference ratios may be changed in proportion to the change of signal, the noise output ratios will not necessarily change in a similar manner.

The noise outputs obtained on the three modulation systems are compared in Fig. 12. Attention is again drawn to the fact that the actual performance obtained may deviate from that shown according to the peculiarities of the particular circuit in use. However, the conditions under which the w.m. sync-pulse receiver was operated are stated in the text, and as it is believed that the a.m. and f.m. receivers had no exceptional features, the results relating to them are used here as a guide by which to assess the performance of the system under test.

The graph shows how the levels of the resulting noise outputs sound to the listener, and it will be seen that the w.m. sync system performs most satisfactorily at high input interference levels. When the interference was heavy on both picture and sound, the circuit in use gave about 12 db less noise output than a.m. When the level was such that there was a small amount of noise on the picture, the noise output on sync sound was about equal to that on a.m., and the noise appeared with an input level about 10 db lower than that required on a.m.

The performance obtained on f.m. was superior to that of each of the other two systems, the noise output being less at all input noise levels. It was, however, very important that the receiver should be tuned accurately for minimum noise output before being used, and it was found that with the receiver in use it was impossible to be sure of reaching this condition merely by tuning for minimum distortion in the normal manner. When the receiver was mistuned, the noise appeared to have the character usually associated with a.m. and as the tuning was corrected in the presence of interference the sound changed and

appeared to consist of higher frequency 'clicks' which were not so annoying. A further increase of noise output on f.m., which is not allowed for in Fig. 12, is that occurring when the signal is modulated[14]. This was mentioned in Section 2.3, and proved very noticeable when subjective readings were taken in the presence of audio modulation.

The graphs now make it clear how it was possible to obtain readings (Section 2.3) suggesting that the performance of sync-pulse sound was similar to that of a.m. It will be remembered that approximately equal inputs were required on both systems for equal noise outputs (at some very low noise level). The graph shows that the curves do intersect at some low level, and that (as found before) the input would have to be increased by about 20 db on f.m. to give an equivalent noise output. Further, when the signals were modulated (Section 2.3) so that a larger output noise level was required, the interference input required on a.m. was 28 db larger than that which was sufficient on sync sound. According to Fig. 12 however, the maximum difference in input levels for the same output on these two modulation systems is about 12 db, but in the simple demodulator used in Section 2.3 (Fig. 6) the window was at the tip of the synchronizing pulse. The graph corresponding most nearly to the condition obtaining before is therefore (3) of Fig. 13, and there the maximum difference is about 26 db. Exact agreement would not be expected because of the different bandwidths, window areas, etc., in the two instances, but Fig. 13 clearly substantiates the earlier readings.

The second intersection of the a.m. and w.m. sync graphs (at a higher noise level) was discussed (Section 3.2) in connection with the listening checks which indicated that the graphs do give a true picture of the noise output variations. Mention was also made (Section 3.3) that the r.m.s. value of the output current (or voltage) appears to represent the level as heard by the listener, and that peak readings should not be used. The r.m.s. readings of the noise output levels at the maximum interference input used are given in Table 4 (a.m. and w.m. sync sound), and Table 6 (f.m.).

An interesting paper[22] by Page and Gouriet, published after the completion of these tests, gives the results of field tests dealing with the effect of ignition interference on f.m. In these tests the authors encountered interference fields giving rise to noise outputs ranging from 'imperceptible' to 'very disturbing'—these being rated to be of the order of 50 db apart. This is approximately the range considered in the investigation reported here, and the probability of the occurrence of the various interference levels of Fig. 12 may be estimated from the f.m. readings in Ref. 22, in which the results of individual vehicles were noted and totalled.

5 Acknowledgments

The author is indebted to Mr. I. Shoenberg and Mr. G. E. Condliffe, Directors of E.M.I. Research Laboratories Ltd., for permission to publish this summary of the investigation, and for facilities granted in its preparation. He also wishes to thank Mr. H. A. M. Clark for the advice received from him throughout the work.

Valuable assistance in performing the many experimental measurements was received from Mr. R. A. Willard.

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V.F. AMPLIFIER COUPLINGS

Unsymmetrical π-Section Filters

By G. G. Gouriet, A.M.I.E.E.

(*Engineering Research Department, B.B.C.*)

SUMMARY—It is shown that, by a suitable choice of the parameters which define the design of unsymmetrical π-section filters, simple expressions for the performance are obtained, from which the steady-state or the transient response may be calculated. Curves of the amplitude characteristic and the group-delay characteristic are given for various values of the variable parameters, and cases of particular interest are discussed. Finally, the requirements of phase-equalizing networks are given, various values of termination and varying degrees of asymmetry, so that filters may not only be readily designed to provide a constant amplitude characteristic but may also be chosen to fulfil the purpose of equalizing networks. Curves of the group-delay characteristic are given in each case and data for the design of phase-equalizing sections are included.

1. Introduction

THE use of π-section filters as a means of providing efficient intervalve couplings in video-frequency amplifiers has received much attention in recent years. Various authors[1] have suggested that the voltage gain-bandwidth product of a stage employing a simple π-section coupling, in which the stray capacitances of the circuit form the shunt elements, is of the order of 1.5 times as great as is obtained using the two-terminal circuit, commonly known as the shunt-peaking network. More complicated couplings employing a combination of the shunt-peaking circuit and the π-section filter, and providing in addition a greater degree of phase linearity, have also been described[2], but the disadvantage of such circuits is the critical nature of the adjustments necessary to obtain the optimum performance. A better solution, particularly applicable to the case of multi-stage video amplifiers, is to adopt the simple filter couplings throughout and correct the overall phase characteristic by means of a suitable phase-equalizing network.

The transient response of the various forms of such couplings has also received considerable attention, but in practice the response of a single section is seldom of interest, while to deduce the overall transient response of a number of cascade sections from that of a single section is, in general, a formidable task. Kallman, Spencer and Singer[3] have dealt comprehensively with the transient response of a large number of alternative types of filter and have included the case of cascade stages by means of an artifice, but the filters treated are without phase correction, and the results are of limited application, since with the efficient types of coupling the degree of overshoot is prohibitive when many stages are used.

The purpose of this article is to present design data and generalized performance curves for

MS accepted by the Editor, December 1949

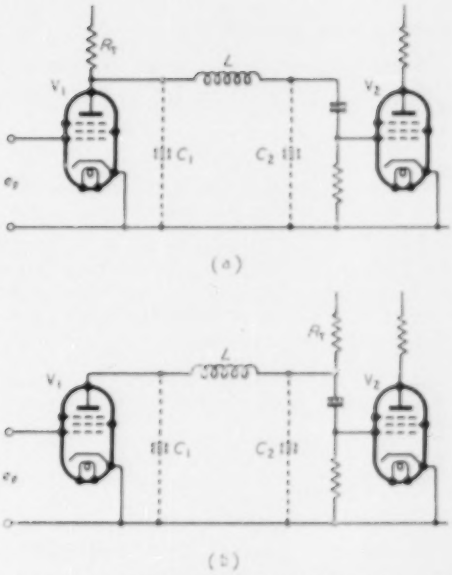


Fig. 1. *π-section filters with input termination (a) and output termination (b).*

2. Design Theory

In this section we shall deal with the design of intervalve couplings of the simple type shown in Fig. 1(a) and (b), and these two cases we shall designate 'input terminated and output term-

inated' respectively. In general, the valve will be a pentode,having an amplification factor and mutual conductance of μ and g_m respectively, and since we are dealing with wide-band video amplifiers, the value of R_T, the terminating resistance, will in all cases be very small compared with the valve a.c. resistance, r_a, and we shall, therefore, justifiably regard the latter as infinite.

The generalized equivalent circuit is shown in Fig. 2, e_g being the voltage applied to the grid of the valve.

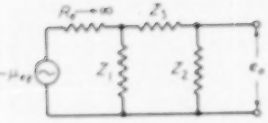


Fig. 2. *Generalized equivalent circuit of filter.*

For the output voltage, e_0, we have,

$$e_0 = -\mu e_g \frac{Z_1 Z_2}{r_a (Z_1 + Z_2 + Z_3) + Z_1 (Z_2 + Z_3)} \quad (1)$$

Putting $\mu = g_m r_a$ where g_m = mutual conductance, and letting $r_a \to \infty$ we obtain

$$e_0 = -e_g g_m \frac{Z_1 Z_2}{Z_1 + Z_2 + Z_3} \quad .. \quad .. \quad (2)$$

Since we are only interested in the characteristic of the transfer impedance Z_T, we may write more simply :—

$$Z_T = \frac{Z_1 Z_2}{Z_1 + Z_2 + Z_3} \quad .. \quad (3)$$

A point of fundamental importance to be noted from (3) is that the characteristic of the network is unaltered by the interchange of Z_1 and Z_2. Thus the networks of Fig. 3(a) and (b) will have identical voltage transfer characteristics, and a generalized analysis is greatly simplified by virtue of this property, as will be shown later.

If the appropriate impedances of the configurations of either Fig. 3(a) or (b) are substituted in (3) we obtain for the normalized voltage transfer factor, θ_T, the following expression,

$$\theta_T = \frac{1}{\frac{p^3 L C^2 R_T}{K} + \frac{p^2 L C}{K} + p C R_T \left(1 + \frac{1}{K}\right) + 1} \quad .. \quad (4)$$

The Heaviside operator p, has been used in place of $j\omega$ since this leads to neater algebra and a more general result.

The question now arises as to what parameters can best be introduced in order to express the performance in general terms.

First, let us consider the choice of terminating resistance. In conventional filter theory for a low-pass filter this is chosen to equal the value of the image impedance at zero frequency, and is termed the design impedance. If, by the standard method, we deduce the image impedances Z_{01} and Z_{02} for the unsymmetrical filter, we obtain at zero frequency

$$Z_{01} = Z_{02} = \sqrt{\frac{K}{1 + K}} \sqrt{\frac{L}{C}} \quad .. \quad .. \quad (5)$$

This value may be defined as $\sqrt{(L/C_0)}$ where C_0 is the sum of the two capacitances C and C/K, which is in agreement with the symmetrical theory when $K = 1$.

Bearing in mind the asymmetry, intuitively, we should not expect the most suitable design impedance to be the same for the alternative terminations. Guided by the principles of impedance transformation, let us regard this as a geometric mean value, and use a value of terminating resistance which is equal to the image impedance at zero frequency modified by a factor equal to the ratio of the terminating reactance and the geometric mean of the two reactances. Designating the input and output terminating resistances as R_{T1} and R_{T2} respectively, we will obtain,

$$R_{T1} = \sqrt{\frac{K}{1 + K}} \cdot \sqrt{\frac{L}{C}} \cdot \frac{X_c}{\sqrt{K X_c^2}} = \frac{1}{\sqrt{1 + K}} \cdot \sqrt{\frac{L}{C}} \quad .. \quad (6)$$

$$R_{T2} = \sqrt{\frac{K}{1 + K}} \cdot \sqrt{\frac{L}{C}} \cdot \frac{K X_c}{\sqrt{K X_c^2}} = \frac{K}{\sqrt{1 + K}} \sqrt{\frac{L}{C}} \quad .. \quad (7)$$

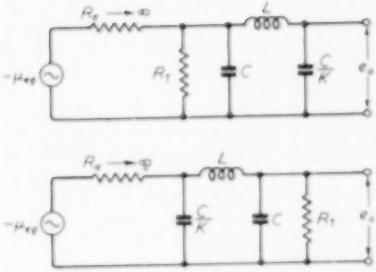


Fig. 3. *Circuits (a) and (b) have identical response characteristics.*

Under these conditions the input-terminated filter will be as shown in Fig. 4(a), while the output-terminated case will be as in Fig. 4(b). The latter has been shown by (3) to be equivalent to the configuration of Fig. 4(c) and by making substitutions

$$\frac{C}{K} = C' \text{ and } K = \frac{1}{k}$$

we obtain the configuration of Fig. 4(d). This will be seen to be identical with that of Fig. 4(a), except that the *reciprocal* value of K has been substituted.

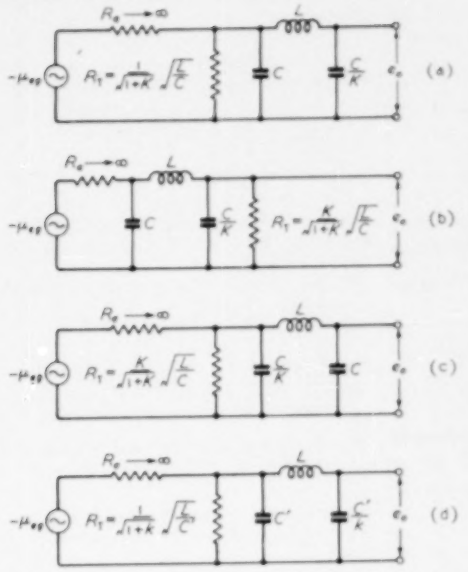


Fig. 4. *Input- and output-termination filters are shown at (a) and (b) with the proper component relations. Equivalent filters are (c) and (d).*

Again, to follow conventional filter theory let us define the design frequency* to be that of the loop resonance, i.e., by

$$\omega_0 L - \frac{1}{\omega_0 C} - \frac{K}{\omega_0 C} = 0 \text{ where } \omega_0 = 2\pi \times \text{design frequency} \quad .. \quad (8)$$

$$\text{whence } \omega_0^2 = \frac{1+K}{LC} \quad .. \quad .. \quad .. \quad (9)$$

As before, making the substitutions

$$\frac{C}{K} = C' \; ; \quad K = \frac{1}{k}$$

$$\text{we get } \omega_0^2 = \frac{1+\frac{1}{k}}{L \cdot \frac{C'}{k}} = \frac{1+k}{LC'} \quad .. \quad .. \quad (10)$$

which is again of identical form to (9), except that the value of k is reciprocal.

Thus we need only examine the case of an input termination, since the corresponding output termination will simply modify the performance characteristic in the same manner as if the value of capacitance ratio had been reciprocal.

In the foregoing we have chosen to define the design frequency by the relationship

$$\omega_0^2 = \frac{1+K}{LC} \quad .. \quad .. \quad .. \quad .. \quad (9)$$

and the terminating resistances as

$$R_{T1} = \frac{1}{\sqrt{1+K}}\sqrt{\frac{L}{C}} \text{ for input termination} \quad .. \quad (6)$$

$$\text{and } R_{T2} = \frac{K}{\sqrt{1+L}}\sqrt{\frac{L}{C}} \text{ for output termination} \quad .. \quad (7)$$

By combining (9) with (6) and (7) we may rewrite the latter equations as

$$R_{T1} = 1/\omega_0 C \quad .. \quad .. \quad .. \quad .. \quad (11)$$

$$R_{T2} = K/\omega_0 C \quad .. \quad .. \quad .. \quad .. \quad (12)$$

Substituting these values for R_T in (4) and also using (9) we obtain, for the transfer factor, θ_{T1}, corresponding to the case of input termination,

$$\theta_{T1} = \frac{\frac{K}{1+K}}{\left(\frac{p}{\omega_0}\right)^3 + \left(\frac{p}{\omega_0}\right)^2 + \frac{p}{\omega_0} + \frac{K}{1+K}} \quad .. \quad (13)$$

and for θ_{T2}, corresponding to output termination,

$$\theta_{T2} = \frac{\frac{1}{1+K}}{\left(\frac{p}{\omega_0}\right)^3 + \left(\frac{p}{\omega_0}\right)^2 + \frac{p}{\omega_0} + \frac{1}{1+K}} \quad .. \quad (14)$$

which factors are identical if $1/K$ is substituted for K in one of them. The simplicity and symmetry of these expressions would indicate that our choice of parameters has been the most suitable.

The transfer factors as expressed in (13) and (14) are in suitable form for direct insertion into the Heaviside expansion theorem, from which the transient response may be deduced. However, the labour involved is formidable and bearing in mind the limited value of this knowledge as has been already discussed, we shall be concerned only with the steady-state response.

Substituting $j\omega$ for p in (13), and using polar co-ordinates, we obtain

$$|\theta_{T1}| \; /\phi = \frac{\frac{K}{1+K}}{\sqrt{A^2+B^2}} \Big/ \tan^{-1} - \frac{B}{A} \quad .. \quad (15)$$

$$\text{where } A = \frac{1+K}{K} - \left(\frac{\omega}{\omega_0}\right)^2$$

$$B = \left(\frac{\omega}{\omega_0}\right) - \left(\frac{\omega}{\omega_0}\right)^3$$

* The term "design frequency" has been chosen rather than "cut-off frequency" since the latter term has no particular significance in the case of the unsymmetrical configuration.

For the group delay, we have by definition

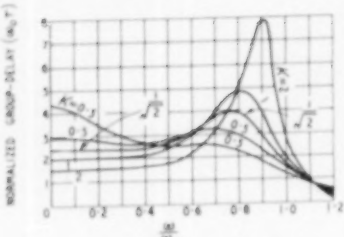
$$\tau = \frac{d\phi}{d\omega} = \frac{d(\omega/\omega_0)}{d\omega} \cdot \frac{d\phi}{d(\omega/\omega_0)} = \frac{1}{\omega_0} \cdot \frac{d\phi}{d(\omega/\omega_0)}$$

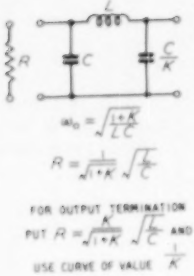
A convenient factor for plotting is thus the normalized delay

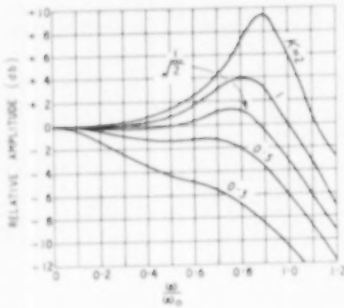
$$\omega_0\tau = \frac{d\phi}{d(\omega/\omega_0)}$$

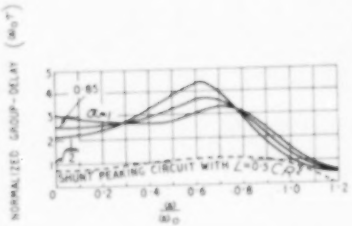
From (15), by differentiation, we obtain,

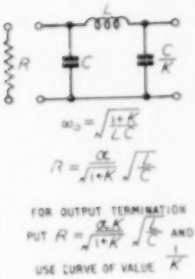
$$\frac{d\phi}{d(\omega/\omega_0)} = \omega_0\tau = -\frac{\left(\frac{\omega}{\omega_0}\right)^2 \cdot \left[\frac{1-K}{1+K}\right] + \frac{K}{1+K}}{A^2 + B^2} \quad (16)$$











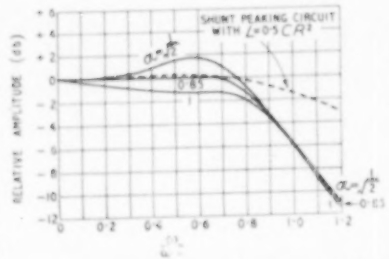


Fig. 5. (left) *Amplitude and group-delay characteristics for various values of K.*

Fig. 6. (below) *Amplitude and group-delay characteristics with change of α for K = 0.5.*

Curves of equations (15) and (16) have been plotted (the former in decibels) in Fig. 5 respectively for various values of K ranging from 0.3 to 2.0.

As has already been pointed out, the corresponding curves for the case of output termination are obtained simply by choosing reciprocal values of K. Before commenting upon these results, there is yet another parameter which may usefully be varied.

If we express the values of the input terminating resistance as

$$R_T = \frac{\alpha}{\sqrt{1+K}}\sqrt{\frac{L}{C}} \quad \ldots \quad (17)$$

we may vary α and thus make the termination depart from the design resistance by any amount we please. Making this substitution in (4) we see that α merely becomes an additional coefficient in the terms containing odd powers of p, whence (15) and (16) become

$$|\theta_{T1}| \angle\phi = \frac{K}{\sqrt{1+K}} \Big/ \tan^{-1} -\alpha\frac{B}{A} \quad (18)$$

$$\omega_0\tau = -\alpha\frac{\left(\frac{\omega_0}{\omega}\right)^2 \cdot \frac{1-K}{1+K} + \frac{K}{1+K}}{A^2 + \alpha^2 B^2} \quad \ldots \quad (19)$$

The effect of varying the value of α over small limits is shown in Figs. 6, 7 and 8 for the cases of $K = 0.5$, 1.0 and 2.0 respectively.

A case of particular interest is that of $K = 0.5$; $\alpha = 0.85$.

This will be seen from Fig. 6 to give an amplitude response which is substantially flat up to a frequency of 0.7 of the design frequency. The corresponding group-delay characteristic over this range does not depart from a constant by

more than approximately $1/2\pi$ times the period of one cycle of the design frequency, which is equivalent to $0.7/2\pi$ or approximately 11% of the period of one cycle of the highest operating

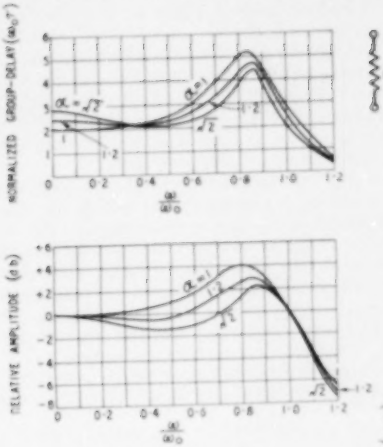


Fig. 7. (above) *Amplitude and group-delay characteristics with change of* α *for* $K = 1$.

Fig. 8. (right) *Amplitude and group-delay characteristics with change of* α *for* $K = 2$.

frequency. Under these conditions, the distortion produced by a single section of the network when accepting waveforms having a spectrum thus restricted will be negligible. The implication of this statement will be discussed in Section 3, which deals with phase correction.

It is interesting to compare the voltage gain of a stage employing this form of coupling with that obtainable from the simple two-terminal network or shunt-peaking circuit shown in Fig. 9 in which C_s represents the total inter-stage stray capacitance. One form of the shunt-peaking circuit which is often used as a basis for comparison[1], and which was described in early literature[5], is obtained by making

$$R = 1/\omega_c C_s = 2\omega_c L$$

where ω_c defines the upper-frequency limit of the working frequency band. This relationship may also be expressed by the equations

$$L = 0.5\, C_s R^2; \quad \omega_c^2 = 1/2LC$$

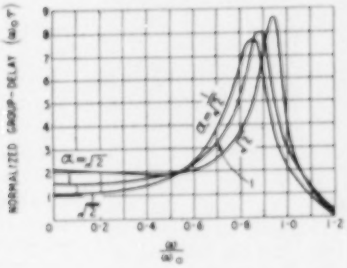
With this arrangement the impedance of the network is approximately constant and numerically equal to the value of R up to the upper angular-frequency limit ω_c, at which limit it is also equal to the value of the stray reactance $1/\omega_c C_s$. The amplitude and group-delay characteristics are shown by the dotted curves in Fig. 6, in which ω_0 is 2π times the resonance frequency of L and C_s.

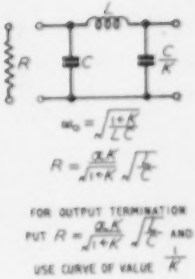
Since the voltage gain is directly proportional to the value of the load resistance, we have, for similar values of stray capacitance and equal frequency bands, in the case of the shunt-peaking circuit

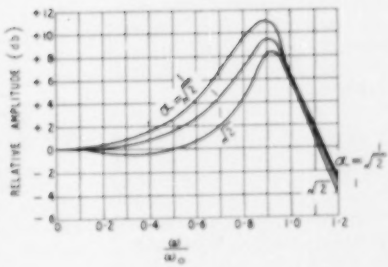
$$\text{Gain (S.P.)} \propto \frac{1}{\omega_c C \left(1 + 1/K\right)}$$

and for the filter

$$\text{Gain (F)} \propto \frac{0.7\alpha}{\omega_c C}$$







whence the ratio

$$\frac{\text{Gain (F)}}{\text{Gain (S.P.)}} = 0.7\alpha\left[1 + \frac{1}{K}\right]$$

$$= \text{approx. } 1.8 \text{ for } K = 0.5 \text{ and } \alpha = 0.85$$

In a multi-stage amplifier, this gain, which amounts to 5 db per stage, is well worth having,

particularly at the wider bandwidths for which the gain per stage is severely limited.

It will be noted that this particular result is restricted in the case of the filter to circuits for which the total stray capacitance involved can be split up into two capacitances with a ratio of

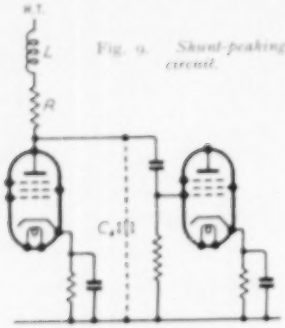


Fig. 9. *Shunt-peaking circuit.*

$x : 1$, but it is immaterial which of the two capacitances is the larger, since if it is the input capacitance an output termination will provide the same characteristic. In a practical case it may be necessary to add a trimming capacitance to the larger of the two to fulfil this condition and the full advantage of 5 db will not be realized. However, in practice, using modern valves, it is usual for the valve input capacitance to be of the order of twice the valve output capacitance and an approximate 'trim' may often be accomplished by choosing the most suitable position for the grid coupling capacitor, as shown in Fig. 10(a) and (b). On the other hand, when coupling the output of a power valve to the grid or cathode of a c.r. tube for modulation purposes, it is common to find that the valve output capacitance, with associated strays, is of the order of twice the c.r. tube input capacitance, and in this case the desired characteristic is obtained with an input termination.

Another response curve of interest is the case of $K = 1$, $\alpha = 1$. (Fig. 7). This is simply the case of the 'constant-k' symmetrical filter, and the response, which rises slowly to a maximum of +4.0 db at approximately 0.8 of the cut-off frequency, is useful for providing a small amount of 'top-lift' to compensate for other deficiencies; for example, aperture distortion. Larger degrees of high-frequency correction may be obtained by using a value $K = 2$, and values of $\alpha < 1.0$.

3. Phase Correction

3.1 *Practical Considerations*

Undoubtedly the most important present day application of video-frequency amplifiers is in the provision of amplification for television signals, and in this section we shall base our discussion in terms of such signals, and concentrate particular attention on the unit-step waveform, which in television corresponds to the sudden transition from a black to a white area or vice versa.

T. C. Nuttall has already made a comprehensive study of phase equalization, and a paper by him dealing with this subject was presented at Zurich, in September 1948 [8]. We shall review the question here, briefly, since it has considerable bearing on the choice of intervalve couplings.

In the previous section it was shown that the characteristic of a coupling filter which has the parameters $K = 0.5$ and $\alpha = 0.85$ (see Fig. 7) is such that a signal will be transmitted through the filter with negligible distortion, provided the spectrum of the signal is limited to a maximum frequency, ω_c, equal to 0.7 of the design frequency, ω_0. If, however, a unit-step signal, obtained, for example, from an ideal camera, is applied to the filter without any modification to its spectrum, the output we should obtain would be of the form

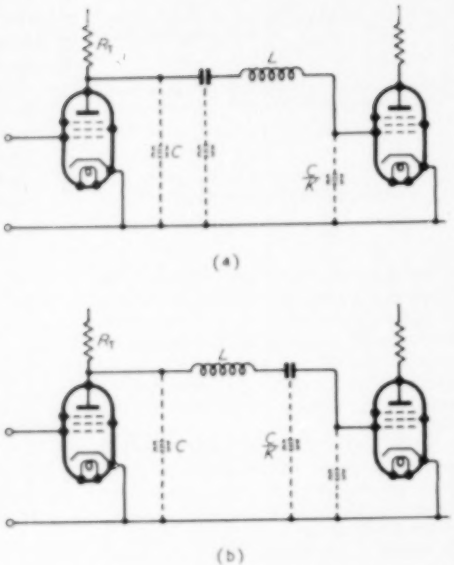


Fig. 10. *Shows how position of grid-coupling capacitor may be chosen to assist 'trimming.'*

shown in Fig. 11(a), and if several stages employing similar couplings were used in cascade, due to the increased rate of cut-off and the more rapid departure from a linear phase characteristic

near the cut-off frequency, the output waveform would be even more distorted and of the form shown in Fig. 11(b). Such response waveforms would, of course, only be acceptable for television, in cases where the cut-off frequency, ω_c, was arranged to be greater than the frequency corresponding to the limiting optical resolution of the reproducing system. In other words, if the pattern produced by the distortion could not be resolved by the reproducing screen, then the distortion would be of no consequence.

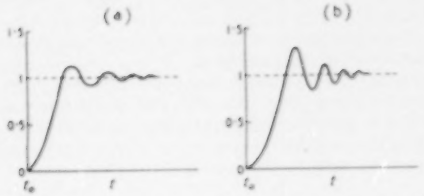


Fig. 11. *Response of single filter to unit-step input (a), and response of cascade filters (b).*

It is also true that if the television camera were incapable of resolving the form of a similar pattern, due, for example, to optical or electro-optical limitations, the distortion caused by the filter would be relatively insignificant. By definition, the spectrum of the signal applied to the filter would then be confined substantially to within the cut-off limit of the filter.

This is in effect saying that it is not permissible to introduce a sharp cut accompanied by phase distortion into the video characteristic except at a frequency higher than that which corresponds to the finest detail which the electro-optical elements of the system can resolve.

Let us consider what this means in terms of a 405-line system of television. If detail corresponding to 405 lines in the horizontal direction is to be reproduced without severe loss of contrast ratio, a video-frequency characteristic is required which is substantially flat up to a limit of approximately 3.0 Mc/s. Since it is not permissible to introduce a sharp cut at this limiting frequency by means of straightforward filters, the complete electrical system should be designed to have a considerably wider bandwith than this, say 5 Mc/s, whether a sharp cut-off or a trailing characteristic is used, and, remembering that in practice the electrical system includes the complete transmitting and receiving apparatus, the requirement is most uneconomical.

As an alternative it might be argued that the whole of the electrical system following the camera tube could be designed to have a cut-off frequency of a little over 3.0 Mc/s, and that cut-off distortion could be avoided by confining the spectrum of the camera output signal to within this limit. Since, however, we require that the response from the camera should be substantially unattenuated at 3.0 Mc/s, this could only be achieved by means of a filter with a very sharp cut-off, which would of course result in the very distortion we are endeavouring to avoid. On the other hand, to limit the spectrum of the camera output signal by means of a gradual cut-off implies that the attenuation must commence at a relatively low frequency, say 1.0 Mc/s, and increase steadily up to the limiting frequency of 3.0 Mc/s, the result of which will be to cause a considerable deterioration in definition.

All this is true when the electrical characteristic is determined by means of conventional filters without phase correction. If, however, a phase equalising network is introduced into the electrical system, so that at the output of the system all components over the pass band arrive with a constant delay (i.e., the overall phase characteristic is linear), a different state of affairs will exist.

Clearly in such circumstances any symmetrical function, whether odd or even, will remain a symmetrical function since only the amplitudes of the components of its spectrum will have been modified, and in the limit for an infinitely sharp cut-off, the waveform resulting from a unit-step input will be of the form shown in Fig. 12. It is a simple matter to show that the resulting time function is in this case the sine-integral function for which the over-shoot is less than 10%, an amount which is scarcely perceptible when viewed on a television screen. For any slower

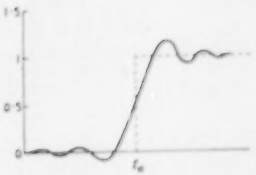


Fig. 12. *Response to unit-step input of a phase-equalized filter.*

rate of cut-off, the overshoot will be less than this, and the waveform of Fig. 12 is therefore representative of the worst case.

It will be noted from Fig. 12 that the arrival of the 'step' is anticipated by ripples which appear in the waveform prior to the time, t_0, at which the step actually occurs. This does not, of course, imply that the ripples occur before the step has been *applied* to the filter, but simply that the phase-equalising network must necessarily introduce a time delay in order to produce the desired effect of advancing the arrival time of the high-frequency components *relative* to that of the low frequencies.

To obtain precise phase-equalization of any practical filter would require an infinite number of sections in the equalizing network, and the delay through the equalizer would thus be infinite. This is obviously true, since if the output waveform due to unit step input is to possess perfect odd symmetry, the ripples must commence at a time $-\infty$ relative to the actual step and an infinite delay is thus a necessary postulate.

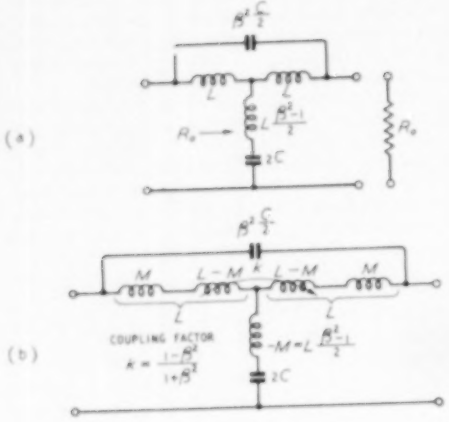


Fig. 13. (above) *Phase-equalizing circuit (a) and the arrangement to be adopted (b) when the shunt inductance is required to be negative.*

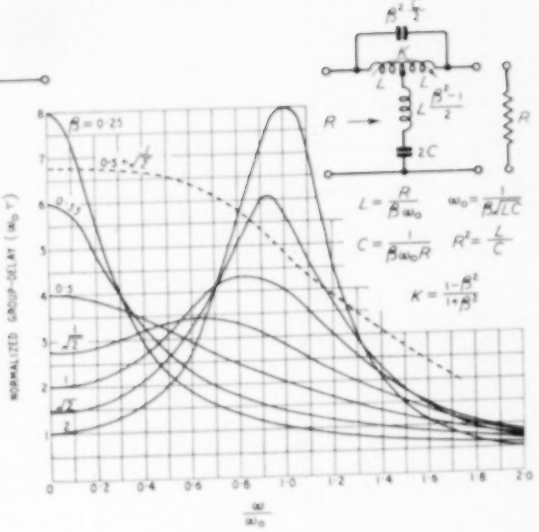


Fig. 14. (right) *Group delay-characteristic of phase equalizer.*

In practice, a delay equal to the period of two or three cycles of the cut-off frequency is sufficient to provide substantial symmetry and an equalizer having four sections is usually adequate.

By means of phase-equalization it is, therefore, possible to obtain a transient response which is satisfactory for television purposes, even though the cut-off frequency of the electrical system is chosen to equal the frequency which corresponds with the finest detail which it is required to resolve.

3.2 *Design of Phase-Equalizing Sections*

A most convenient form of phase-equalizing section is the bridged-T equivalent of the all-pass constant-resistance lattice structure, as shown in Fig. 13(a). The parameters of such a section may be defined as follows:

$$L = \frac{R_0}{\beta\,\omega_0}\ ;\quad C = \frac{1}{\beta\,\omega_0\,R_0}$$

where L, C and R_0 are as shown in Fig. 13(a) and β is a design constant which determines the equalizing characteristic.

We thus have,

$$R_0^2 = \frac{L}{C}\ ;\ \text{and}\ \omega_0^2 = \frac{1}{\beta^2\,L\,C}$$

Since the network has an all-pass characteristic the only significance of ω_0 is that it is a design frequency which will determine the range over which a given phase characteristic will be obtained.

For a given termination and design frequency the only variable parameter is β and the transfer constant may be expressed as

$$\theta = 1.0 \Big/ 2\tan^{1-}\beta\left[\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right]$$

Differentiating the argument with respect to ω we obtain for the normalized group delay

$$\omega_0\tau = \frac{2\beta\left[1 + \left(\frac{\omega}{\omega_0}\right)^2\right]}{\beta^2\left[1 - \left(\frac{\omega}{\omega_0}\right)^2\right]^2 + \left(\frac{\omega}{\omega_0}\right)^2}$$

Curves of this expression are given in Fig. 14

for values of β ranging from $\beta = 0.3$ to $\beta = 4.0$.

It will be noted that for values of $\beta < 1.0$ the inductance in the shunt element is negative and is therefore provided by mutual coupling between the two inductances in the series element, as shown in Fig. 13(b). If the coupling factor, k, is expressed in terms of β we obtain

$$k = \frac{1 - \beta^2}{1 + \beta^2}$$

The process of designing a phase equalizer for correcting a given filter characteristic is unavoidably tedious. Assuming that the group-delay characteristic of the filter is known, the simplest method is to 'combine' various equalizing characteristics by trial and error, using the curves of Fig. 14, until a satisfactory compensating characteristic is obtained. By a suitable choice of ω_0, the working range of each section may be made to coincide with any desired frequency band, and for a complete equalizer the value of ω_0 is not necessarily the same for all sections.

A useful combination which may be used as a basis for equalizing most forms of filter is two sections comprising

$$\text{one } \beta = \frac{1}{2} \text{ and one } \beta = \frac{1}{\sqrt{2}}$$

The combined characteristic is shown dotted in Fig. 14, and will be seen to provide a delay in the arrival time of frequency components which is at first gradually and then rapidly reduced as the frequency is increased.

Conclusions

A systematic approach to the design of simple π-section intervalve coupling filters has been described and the general question of phase-equalization has been discussed. It is considered that video-frequency amplifiers involving many stages may be designed most efficiently and simply by using these filters throughout and applying overall phase correction by means of a phase-equalizing filter.

Acknowledgment

The writer wishes to thank the Chief Engineer of the British Broadcasting Corporation for granting permission to publish this article, Mr. H. L. Kirke, C.B.E., M.I.E.E., under whose direction the work has carried out, and also Mr. T. C. Nuttall, of Cinema-Television, Limited, for helpful discussions.

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NARROW-PULSE GENERATOR

For Calibrating Noise-Measuring Sets

By C. S. Fowler, A.M.Brit.I.R.E.

(Communication from the National Physical Laboratory)

1. Introduction

This paper describes the design of a generator of pulses of known amplitude and known repetition rate, the latter being adjustable so as to provide either single pulses, or recurrent pulses having a repetition frequency between 5 and 5,000 pulses per second, and the shape of the pulses being such as to give an energy spectrum flat within 0.2 db up to 30 Mc/s and only 1 db down at 40 Mc/s.

Such a generator is required for the calibration of radio noise-measuring sets. It is also useful for the study of the frequency characteristics of radio receivers and of networks generally.

MS accepted by the Editor, January 1950.

2. Pulse-Forming Circuit

The pulse-forming circuit is similar to one developed by the U.S. Signal Corps,[1] and is shown in Fig. 1.

The pulses are produced by the discharge of the capacitor C through R_1 and the thyratron V_1, the fall of potential at P is then differentiated in the network C_1R_A, (where R_A is the effective resistance between X and earth of the portion of the circuit to the right of AA) to form the output pulse.

The thyratron used is the miniature 2D21—a Xenon-filled tetrode capable of passing 500 mA peak cathode current, with an ionization time of between 0.05 and 1 μsec and a normal de-ionization time of 130 μsec. The ionization time falls with increasing triggering voltage and is approximately 0.3 μsec for a pulse of some 60-volts amplitude.

The de-ionization time can be reduced by holding the grid highly negative between triggering pulses. With a holding potential of some 95 volts repetition frequencies of the order of 7,000 c/s have been obtained without erratic operation of the thyratron.

The shape of the output pulse and its amplitude are dependent on the inductance of the leads forming the output network and on the stray capacitances between point X, Fig. 1, and earth.

In order to minimize these effects the thyratron is mounted on a sub-chassis immediately over the output attenuator network, capacitor C_1 forming the lead through the chassis between the thyratron anode pin and R_2, as shown in Fig. 5.

3. Triggering Circuit

The circuit used to generate the required repetition frequency, and to trigger the thyratron, is shown in Fig. 2. It consists of a blocking oscillator driving a cathode-coupled multivibrator.

The frequency of the wide-range blocking oscillator[3] is controlled by the 5-MΩ potential divider (Section A, Fig. 2), and, with the nominal values of components shown, covers 5 to 5,300 c/s.

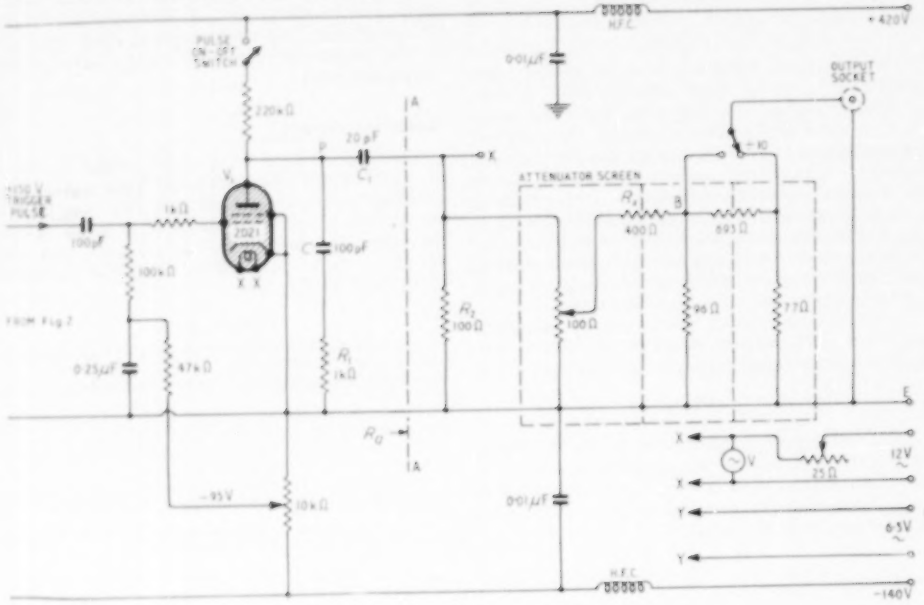

Fig. 1. *Pulse-forming circuit and attenuator.*

The blocking-oscillator frequency is critically dependent on the h.t. and bias voltages, as is the amplitude of the pulse generated by the thyratron, making regulated supplies essential. Two 280/40 stabilovolts connected in series were used in the original power pack, with the earth connection arranged to give 420 volts positive and 140 volts negative, the total current consumption being 22 mA.

The waveform of the pulses from the blocking oscillator is not suitable for directly triggering the thyratron, the triggering pulse for which is obtained from the cathode resistor of the multivibrator (Section B, Fig. 2) which in turn is triggered by negative pulses obtained from the blocking-oscillator anode.

The pulse produced by the multivibrator has an amplitude of approximately 150 volts positive and a duration of some 20 μsec. This is differentiated before application to the thyratron grid.

The amplitude of the thyratron output pulse

was found to be somewhat dependent on the triggering pulse amplitude especially at the higher frequencies. To avoid this effect a compensating inductance is used in the multivibrator circuit, which is otherwise of normal construction.

Single pulses are obtained by switching off the blocking oscillator to prevent possible break through, and applying negative pulses by means of a push switch.

4. Performance

4.1 *Theory*

It is convenient to describe the amplitude of a pulse in terms of the equivalent sine-wave voltage. This is the sine-wave voltage which has an amplitude equal to the peak amplitude of the pulse as observed in the particular network under consideration.

For a pulse derived from the discharge of a capacitor through a resistor, it can be shown (see Appendix) that the equivalent r.m.s. sine-wave voltage is given approximately by:

$$E = \sqrt{2}\, V_0 RC\Delta f \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where

E = equivalent r.m.s. sine-wave voltage,
V_0 = voltage to which the capacitor is charged,
C = capacitance (farads),
R = discharge resistance (ohms),
Δf = bandwidth in c/s of circuit in which voltage is developed.

For the circuit shown in Fig. 1

$$E = \sqrt{2}\, V_0 R_A C_1 \Delta f K_1 \times 10^6 \quad \ldots \quad (2)$$

E = equivalent r.m.s. sine wave in microvolts at B with the variable attenuator set at full output,
V_0 = h.t. voltage less thyratron drop,
R_A = resistance of input to the attenuator network at A A',
Δf = bandwidth in c/s,
R_B = resistance between B and earth of the circuit to right of B,
R_s = series resistance,
$K_1 = R_B/(R_s + R_B)$.

Inserting in (2) the measured values $V_0 = (420 - 10)$, $R_A = 45.5\ \Omega$, $C = 24 \times 10^{-12}$F, $\Delta f = 1{,}000$ c/s, $R_B = 85\ \Omega$, $R_s = 400\ \Omega$, $K_1 = 0.175$,

E = 110 μV r.m.s. at B

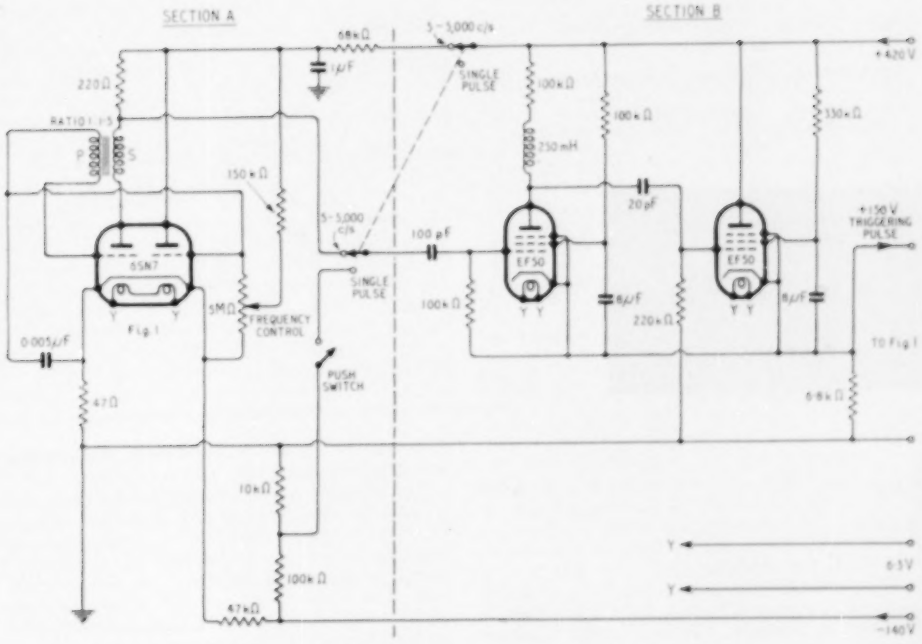

Fig. 2. *Variable frequency triggering voltage generator.*

A further attenuation factor of 0.005 was introduced between the full output and the voltage applied to the receiver during the measurements, giving theoretically 0.55 μV r.m.s.

4.2 Measurement

The performance of the generator was measured using stabilized h.t. and bias supplies of +420 and − 140 volts. The thyratron grid bias was set to − 95 volts and its heater voltage to 6.8 volts. For measurements of the r.f. spectrum two receivers both having built-in attenuators were used, one covering the range 300 kc/s to 25 Mc/s and the other 18 to 120 Mc/s. The r.f. bandwidths were wider than the i.f. bandwidths to ensure a constant effective bandwidth over all ranges.

The pulse repetition rate was kept at 400 c/s throughout the series of measurements. The generator output and receiver attenuators were adjusted so that a suitable output amplitude was obtained without overloading of the receivers occurring at any frequency. The receiver tuning was then set at a specific frequency, the output from the pulse generator applied to the input, and the output amplitude measured on an oscilloscope.

Similar measurements were made on other frequencies between 300 kc/s and 90 Mc/s, the receiver gain being set to the same value each time with the aid of a standard signal generator. The measured relative voltage spectrum is plotted in Fig. 3.

To determine the equivalent sine-wave voltage by measurement, the amplitude versus frequency characteristic of a suitable 2.25-Mc/s amplifier was plotted in the normal manner, and the area under the resulting curve measured, this was divided by the response at the mean frequency to obtain the bandwidth of an equivalent idealized amplifier.

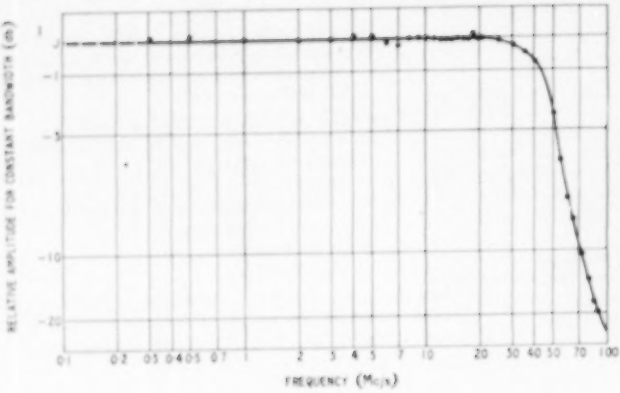

Fig. 3 (above). *Pulse generator frequency spectrum.*

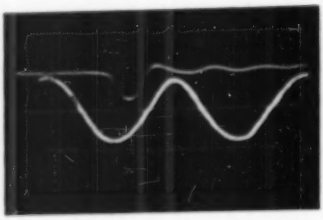

Fig. 4 (below). *Oscillogram of output pulse.*

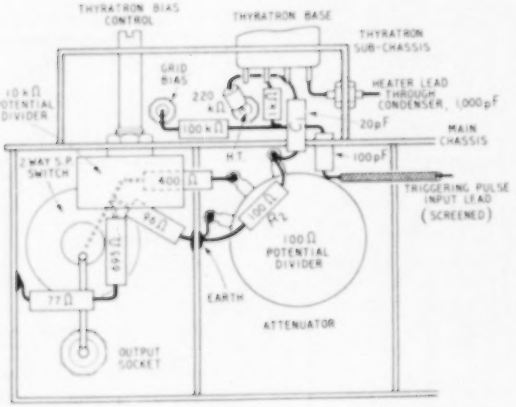

Fig. 5 (right). *Thyratron sub-chassis and attenuator compartment. View from rear of panel.*

The output of the pulse generator was then applied to the input of the amplifier and the peak amplitude of the pulse as displayed on the oscilloscope noted. A standard signal generator tuned to the mean frequency of the amplifier was then substituted for the pulse generator and its output adjusted to give the same peak amplitude on the oscilloscope as was obtained from the pulse generator. Both inputs were

applied to the amplifier through an attenuating resistive pad to minimize detuning effects on the first circuit.

The results of the above measurements were as follows :—

Equivalent amplifier bandwidth	= 27.5 kc/s
Sine-wave voltage to give same peak indication as pulse generator corrected for terminating-pad impedance	= 20.6 μV
Dividing factor of terminating pad	= 10

These figures give a measured value of equivalent sine-wave voltage of 0.75 μV per kc/s compared with the theoretical value of 0.55 μV per kc/s already derived.

5. Conclusions

The shape of the pulse produced by the generator as observed on a particular high-speed oscilloscope is shown in Fig. 4, the timing wave having a frequency of 25 Mc/s and the horizontal lines representing 50- and 100-volt levels measured from the pulse base line.

From this oscillogram the apparent pulse width is 0.01 μsec which is some ten times the true pulse length of the discharge time constant. Moreover the amplitude is seen to be 38 volts, which is about one-tenth of the charging voltage V_0. This indicates that the oscillograph circuit was not capable of indicating the true form of such narrow pulses; i.e., of time duration 0.001 μsec.

The approximate theory indicates the order of magnitude of the equivalent sine-wave voltage but, as is seen from the discrepancy between measured and calculated values, it is not apperently sufficiently accurate to enable the instrument to become an absolute standard.

Also as shown in the Appendix the output pulse voltage is independent of the network CR_1 which is only necessary to ensure regular firing of the thyratron, again the exact manner in which the thyratron resistance changes during the discharge time does not enter the calculation as long as $f \ll 1/RAC_1$.

Acknowledgments

The work described above was carried out as part of the programme of the Radio Research Board. This paper is published by permission of the Director of the National Physical Laboratory and the Director of Radio Research of the Department of Scientific and Industrial Research.

The co-operation of the British Electrical and Allied Industries Research Association, in the use of their high-speed oscillograph in order to obtain the photograph of the pulse, is gratefully acknowledged. The author desires to acknowledge the assistance of R. E. Burgess in connection with the mathematical analysis.

APPENDIX

Equivalent sine-wave voltage of a capacitance-resistance discharge voltage

Let $E(t)$ be an impulse voltage commencing at $t = 0$. Then its frequency spectrum $F(f)$ is given by the Fourier transform

$$F(f) = \int_0^\infty E(t)\, e^{-j\omega t}\, dt$$

Correspondingly, $E(t) = \int_{-\infty}^{+\infty} F(f) e^{j\omega t}\, df \quad \omega = 2\pi f$

Thus in a narrow frequency interval Δf at f the spectral component of $E(t)$ can be written as

$$e(t) = [F(f)e^{j\omega t} + F(-f)\, e^{-j\omega t}].\ \Delta f$$
$$= 2\,(R_e F(f) \cos \omega t - I_m F(f) \sin \omega t).\ \Delta f$$

where R_e and I_m denote real and imaginary parts. The amplitude of the voltage of frequency f in a bandwidth Δf is therefore

$$A(f) = 2\,|\,F(f)\,|\ \Delta f$$

and the r.m.s. value of the equivalent sine-wave voltage is thus

$$e_{r.m.s.} = \sqrt{2}\,|\,F(f)\,|\ \Delta f$$

If the impulse is due to a capacitance C discharging from a voltage V_0 through a resistance R its time variation is given by

$$E(t) = V_0 e^{-t/RC}$$

whence $$F(f) = \frac{V_0 RC}{1 + j\omega RC}$$

giving $$|\,F(f)\,| = \frac{V_0 RC}{\sqrt{1 + \omega^2 R^2 C^2}}$$

hence $$e_{r.m.s.} = \frac{\sqrt{2}\, V_0 RC\ \Delta f}{\sqrt{1 + \omega^2 R^2 C^2}}$$

If now $\omega^2 C^2 R^2 \ll 1$, the spectrum is flat and given by

$$e_{r.m.s.} = \sqrt{2}\, V_0 RC\ \Delta f$$

showing that the equivalent r.m.s. voltage is determined by the area $V_0 RC$ of the impulse $E(t)$. In general when the impulse duration is short compared with $1/\omega$

$$F(f) = \int_0^\infty E(t)\ .\ dt$$

In the actual circuit under consideration (Fig. 1) the impulse voltage E is developed across R_A and its low-frequency spectrum is independent of the network CR_1 and the manner in which the thyratron resistance changes with time. This may be shown as follows :—

$E = R_A C_1 \dfrac{dV_{C1}}{dt}$ where V_{C1} = voltage across C_1

E = voltage across R_A

V_0 = charge voltage

$$\int_0^\infty E\,dt = R_A C_1 \Big| V_{C1} \Big|_0^\infty$$

$$= R_A C_1\ V_0$$

whence $e_{r.m.s.} = \sqrt{2}\, V_0\, R_A C_1\ .\ \Delta f$ when $f \ll 1/R_A C_1$.

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CORRESPONDENCE

Letters to the Editor on technical subjects are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

Surface Wave Transmission Line

SIR,—Your Editorial in the July number has been read with great interest, and has led to experimental work being carried out upon Surface Wave Transmission. This experimental work reveals clearly that the effect of the dielectric coating is not to improve the transmission properties of the wire in between the launching and collecting horns, as perhaps might be inferred from your Editorial, but to reduce the launching and collecting losses at the horns. This is completely in accord with the curves given in Fig. 4 of the Editorial. These show an increase in transmission losses along the wire as the dielectric thickness is increased, as evidenced by the rising curves marked L_t and L_w. The curve L_h on the other hand, which defines the launching and collecting losses for the particular horns used, falls as the thickness is increased, with the result that the total transmission loss is a minimum with a dielectric coating.

It would seem to be obvious, therefore, that the part played by the dielectric coating is merely to concentrate the electric field near the horns and thus with a given size of horns, to obtain an improved overall effect.

There is sufficient experimental evidence to show that the correct procedure, to obtain minimum losses in any given system, using Surface Wave Transmission, is to use bare wire between the terminal devices, and correctly to design the latter by properly shaping the metal horns, and/or using tapered dielectric loading on the parts of the conductor which come within the field of the horns.

N. M. RUST.

Marconi Wireless Telegraph Co. Ltd.,
Great Baddow, Essex.

As Mr. Rust states, the effect of the dielectric coating is to keep the field closer to the wire and thus improve the efficiency of the launching and collecting horns. It cannot improve the transmission along the wire, for dielectric losses are added to the conductor losses, as shown in Fig. 4. We agree with the suggestion that a bare wire might be used with a tapered dielectric loading within the field of the horns; in this way a high efficiency could be obtained with relatively small horns, without any dielectric losses in the line. This assumes, of course, that the line is far enough removed from any surrounding material in which losses might be induced.

G. W. O. H.

Amplifier with a Negative-Resistance Load

SIR,—In connection with the paper by D. M. Tombs and M. F. McKenna (*Wireless Engineer*, June 1950, p. 189), a practical application of the principle may be of interest. In *Electronics* of June 1946 I described a "Reentrant Pentode A-F Amplifier," a resistance-coupled audio amplifier with two stages cascaded along a single electron stream. The first and second grid form a triode; the amplified voltage from the second grid is impressed upon the third grid which, together with the anode, forms another triode.

The third grid functions by distributing the space current between anode and second grid and therefore its mutual conductance with respect to the second grid is negative. A negative admittance is thus added in parallel to the load resistance of the first triode section. In normal operation, the resultant total load is negative. The voltage gain in the first triode is normally 30 although μ is 17. These relations are described in greater detail in the above-mentioned article, p. 124.

The arrangement was used in a hearing aid made by Zenith Radio Corporation in the United States in 1944, using the Raytheon CK511 valve which was designed especially for this circuit. To resolve any questions regarding the practicability of "larger-than-mu" arrangements, it might be noted that more than 100,000 of these instruments were successfully used in the field.

ROBERT ADLER.

Zenith Radio Corporation,
Chicago, U.S.A.

X-Cut Quartz Crystals

SIR,—I am disappointed that F. M. Leslie, in his paper "X-Cut Quartz Crystals" in the June *Wireless Engineer*, shows only an approximate equivalent circuit. An exact equivalent which explains the behaviour of a quartz transducer under all conditions is possible.

The conventional equivalent circuit of a quartz crystal, applicable for frequencies near to resonance, is that of Fig. 1. A. T. Starr[1] showed that the series *LC* circuit could with greater accuracy be replaced by a transmission line as in Fig. 2. This representation is valid in all cases where the acoustic loading on the active faces of the crystal is symmetrical.

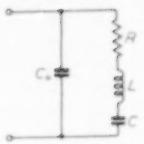

Fig. 1.

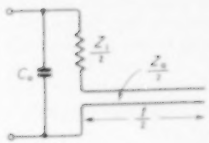

Fig. 2.

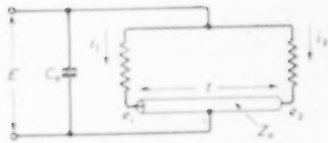

Fig. 3.

To cover the general case of unsymmetrical acoustic loading of any magnitude we have to take the circuit of Fig. 3. This consists of a transmission line of length equivalent to the crystal thickness, shown as a coaxial for clarity. The outer of the coaxial forms one of the external terminals and the two ends of the inner are taken to the other terminal via impedances Z_1 and Z_2. These impedances are equivalent to the acoustic loads on the two crystal faces, respectively, and need not necessarily be resistive.

Treating the transmission line as a quadripole, the equations connecting the voltages and currents at the ends may be written:—

$$e_1 = -jZ_0 (i_1 \cot \beta t + i_2 \operatorname{cosec} \beta t) \quad \ldots \quad \ldots \quad (1)$$

$$e_2 = -jZ_0 (i_2 \cot \beta t + i_1 \operatorname{cosec} \beta t) \quad \ldots \quad \ldots \quad (2)$$

In Fig. 3 the voltage across the external terminals,

$$E = i_1 Z_1 + z_1 = i_1(Z_1 - jZ_0 \cot \beta l) - i_2 jZ_0 \operatorname{cosec} \beta l \quad (3)$$

also $E = i_2 Z_2 + z_2 = -i_1 jZ_0 \operatorname{cosec} \beta l + i_2 (Z_2 - jZ_0 \cot \beta l)$ .. .. (4)

Solving (3) and (4) for i_1 and i_2 we have

$$i_1 + i_2 = E \frac{(Z_1 + jZ_0 \operatorname{cosec} \beta l - jZ_0 \cot \beta l)}{Z_0^2 \operatorname{cosec}^2 \beta l + (Z_1 - jZ_0 \cot \beta l)} + \frac{(Z_2 + jZ_0 \operatorname{cosec} \beta l - jZ_0 \cot \beta l)}{(Z_2 - jZ_0 \cot \beta l)}$$

$$= E \frac{Z_1 + Z_2 + z jZ_0 (\operatorname{cosec} \beta l - \cot \beta l)}{Z_1 Z_2 + Z_0^2 - jZ_0 (Z_1 + Z_2) \cot \beta l} \quad .. \quad (5)$$

Hence the input impedance at the terminals (omitting the capacitance C_0) is,

$$Z_{in} = \frac{Z_1 Z_2 + Z_0^2 - jZ_0 (Z_1 + Z_2) \cot \beta l}{Z_1 + Z_2 + z jZ_0 (\operatorname{cosec} \beta l - \cot \beta l)}$$

$$= Z_0 \frac{Z_1 + Z_2 + j\left(Z_0 + \frac{Z_1 Z_2}{Z_0}\right) \tan \beta l}{2 Z_0 \left(\frac{\cos \beta l - 1}{\cos \beta l}\right) + j(Z_1 + Z_2) \tan \beta l} \quad .. \quad (6)$$

If we put $Z = z/m^2$, this is the same as the impedance of the quartz crystal derived by F. M. Leslie[2]. The circuit of Fig. 3 may thus be used without any restrictions on the magnitudes of Z_1 and Z_2.

It is interesting to consider how this circuit explains the behaviour of an acoustically-loaded crystal under various circumstances.

(1). If the loading is symmetrical, $Z_1 = Z_2$, the current and voltage distribution in the transmission line is symmetrical and it may therefore be 'folded-over' on itself producing an open-circuited line of impedance $\frac{1}{2}Z_0$ and length $\frac{1}{2}l$ in series with an impedance of $\frac{1}{2}Z_1$, which is Dr. Starr's circuit of Fig. 2.

If Z_1 is resistive, at frequencies near to resonance the circuit of Fig. 1 may be used. The values which are obtained for the series LCR circuit at the fundamental resonance ($l = \frac{1}{2}\lambda$) are :—

$$Q = \frac{\omega_0 L}{R} = \frac{\pi}{4} \cdot \frac{Z_0}{Z_1}; \quad C = \frac{4}{\pi^2 f_0 Z_0}; \quad L = \frac{Z_0}{16 f_0} \quad (7)$$

For example, with both faces in contact with water

$$Z_0/Z_1 = 10; \quad Q = 7.8$$

with both faces in contact with mercury

$$Z_0/Z_1 = 0.76; \quad Q = 0.6.$$

(2). If one face of the crystal could be made perfectly rigid ($Z_2 = \infty$) the circuit then becomes an open-circuited line of length l in series with Z_1. The fundamental series resonance is now at $l = \frac{1}{4}\lambda$; i.e., at half the normal frequency, there being an antiresonance (high impedance) at $l = \frac{1}{2}\lambda$.

The constants of the equivalent lumped circuit are now :—

$$Q = \frac{\pi}{4} \frac{Z_0}{Z_1}; \quad C = \frac{4}{\pi^2 f_0 Z_0}; \quad L = \frac{Z_0}{4 f_0} \quad .. \quad .. \quad (8)$$

(3). When the damping on one face is very small ($Z_2 = 0$) equation (6) reduces to

$$Z_{in} = Z_0 \frac{Z_1/Z_0 + j \cot \frac{\beta l}{2} \left\{\frac{Z_1^2}{Z_0^2} \frac{\cos \beta l}{(\cos \beta l - 1)} - 2\right\}}{4 + \frac{Z_1^2}{Z_0^2} \cot^2 \frac{\beta l}{2}} \quad (9)$$

It is interesting to note the change of form of this impedance with respect to frequency when Z_1/Z_0 is changed. This is shown in Fig. 4 where the reactance is plotted for various values of Z_1/Z_0. The change from a half-wave resonator when Z_1/Z_0 is small to a quarter-wave resonator, when Z_1 is large, can be seen.

For $Z_1/Z_0 = 2$ it is seen that no series resonance is present at any frequency. This explains the result of an experiment where a quartz crystal was firmly cemented in a block of steel of acoustic impedance approximately twice that of quartz. Impedance measurements over a wide range of frequency did not reveal any resonance corresponding to the quartz crystal.

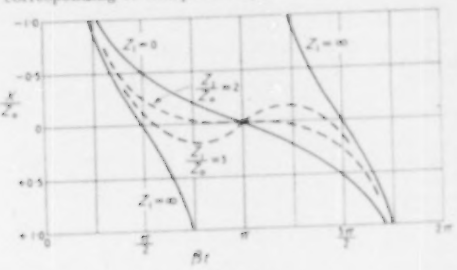

Fig. 4.

If Z_1 is less than $2Z_0$ then at frequencies near to $l = \lambda/2$ the series circuit of Fig. 1 may be used, the constants being :—

$$Q = \frac{\pi}{4}\left(\frac{2Z_0}{Z_1} - \frac{Z_1}{2Z_0}\right); \quad C = \frac{8}{\omega_0 Z_0 \left(1 - \frac{1}{4}\frac{Z_1^2}{Z_0^2}\right)}$$

For example, with one face only in contact with water $Q = 15$ and with one face only in contact with mercury $Q = 0.7$.

In conclusion, I would like to point out two errors preceding equation (4) of F. M. Leslie's article. The expressions $-\xi'_1 S_1 = z_1$ and $\xi'_2 S_2 = z_2$ should be $-S_1/\xi'_1 = z_1$ and $S_2/\xi'_2 = z_2$.

H. Grayson

Standard Telecommunication Laboratories Ltd.,
Enfield, Middx.

REFERENCES.

1 "Electro-Acoustic Reactions," by A. T. Starr, *Wireless Engineer*, June 1940.

2 "X-Cut Quartz Crystal," by F. M. Leslie, *Wireless Engineer*, June 1950.

VELOCITY OF LIGHT

A new measurement of the velocity of light has been carried out by Dr. L. Essen at the National Physical Laboratory and it has been found that the normally accepted figure is in error by 11 miles per second. The new measurement of 186,282 miles per second confirms a previous measurement by Dr. Essen, announced in 1947, and since confirmed by other measurements in Sweden and in the U.S.A.

The determination was carried out at a radio-frequency of 10,000 Mc/s by measuring the resonant wavelength of a cavity resonator having its dimensions accurate to within one-hundred thousandth of an inch and the frequency of oscillation to 1 part in 10^6. The resonator was in the form of a tube 7-in long.

BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

An exhibition of British scientific and industrial instruments is to be held in the National Hall, Olympia, from 4th to 14th July 1951. It is not confined to electrical apparatus. The organizers are F. W. Bridges & Sons Ltd., Grand Buildings, Trafalgar Square, London, W.C.2.

NEW BOOKS

Aerials for Centimetre Wave-lengths

By D. W. Fry and F. K. Goward. Pp. 172 + x. Cambridge University Press, 200 Euston Road, London, N.W.1. Price 18s.

The title of this monograph might more accurately have been "Centimetric Wave-Length Aerials for Radar." While radar applications have comprised not only the major utilization of these very high frequencies, but also the need urging the development of the appropriate technique, there is, nevertheless, an important and increasing usage in the communications field. It is true, as the authors remark in their introduction, that centimetric aerials for other applications introduce few problems not encountered in radar work, but by far the greater proportion of their book is devoted to those aerial characteristics and problems which are peculiar to radar. These include the production of specially-shaped polar diagrams, the use of long linear arrays to obtain beams narrow in one plane and wide in another, and means for scanning; i.e., cyclically varying the direction of the beam so that it sweeps continuously over a required area. Consideration of non-scanning and omni-directional aerials having little radar significance is relegated to an appendix.

The authors have assumed considerable technical knowledge on the part of their readers; in any event, few could appreciate the problems of centimetric work without graduating from lower frequencies. The quasi-optical nature of the subject is well covered, and emphasis is placed on the direct applicability of optical principles to the solution of aerial problems. Fourier analysis and other methods for the design of a radiating aperture to meet specified conditions are discussed, but the treatment is not excessively mathematical. Frequent references are given in the text where further explanation or greater detail may be desired, and a useful bibliography is included.

From an engineering standpoint, a possible criticism is that much that is important or interesting is treated rather superficially. It is less a complete exposition of the design of centimetric aerials than a record of the various types, with explanations to ensure that the objects of a design, the controlling parameters, and the manner of its achievement are appreciated.

The book is well written, with only occasional lapses into professional jargon. The explanatory diagrams are clearly drawn, and there is a notable freedom from textual and typographical errors.

C. G.

The Theory and Design of Inductance Coils

By V. G. Welsby, Ph.D., A.M.I.E.E. Pp. 180 with 61 diagrams and photographs. Macdonald & Co. (Publishers) Ltd., 43 Ludgate Hill, London, E.C.4. Price 18s.

This book will be welcomed by engineers in the many branches concerned with the applications of inductors, for it supplies a very definite need. The calculation and measurement of the inductance of air-cored and low-frequency iron-core coils is, of course, easy work for most designers, and Dr. Welsby has therefore devoted most of his space to the far more difficult problems of coil losses and of iron-core coils at high frequencies. In addition to collecting and adapting existing information for the benefit of the coil designer, he has contributed original work on the design of stranded wire and graphical aids. He frankly admits that much remains to be done, and that some types of inductor (notably non-toroidal dust-core types) are not amenable to exact design, and the use of theory is mainly as a guide in interpreting and applying the results of measurements on sample coils. For this reason it must not be supposed that the design of such coils is reduced to merely evaluating formulae and reading graphs. One must have an intelligent appreciation of the assumptions and limitations involved.

After assessing the various kinds of losses in air-cored and iron-cored coils, the author applies the results in terms of Q, especially in relation to frequency. There is a chapter on harmonic distortion in iron-core coils, one on measurements (its rather sketchy nature being perhaps excusable on the ground of the abundance of existing information), and the book ends with a chapter for which the practical designer will be particularly grateful, consisting of typical examples of coil design.

The problems of eddy-current losses in conductor and core and of hysteresis losses are gone into thoroughly. Dielectric losses and low-capacitance windings receive surprisingly little attention; there is no reference at all to wave winding and similar methods. The book is sufficiently up to date to include a brief description of ferrite core materials; this will no doubt have to be expanded in later editions.

A very helpful addition would be a list of symbols, especially as one or two of them make their appearance without being introduced to the reader. A bibliography is provided, but there are very few references in the text. This is especially unfortunate in those cases where the derivation of equations is not indicated. For example, Chapter VIII is based largely on an expression introduced with the words "It can also be shown that, making certain assumptions . . .", the assumptions not being stated. There are more than a few errors, and before using equations it is advisable to check them. The definition of Q, and the symbols used to refer to it, are rather loose; and there are some discrepancies between diagrams and text.

There is no doubt, however, that this is a book that every communication engineer ought to study.

M. G. S.

Communication Circuit Fundamentals

By Carl E. Smith. Pp. 401 + x. McGraw-Hill Publishing Co. Ltd., Aldwych House, London, W.C.2. Price 42s. 6d.

If any type of book demands more careful writing than another, it is that which purports to teach the basis of a subject *ab initio*. As in building, sound practice requires that each brick be supported on those already laid rather than by those yet to come. Ambiguities should be strictly excluded, and statements should avoid looseness on the one hand and pedantry on the other.

The framework of the book under review is well adapted to its purpose, mainly as part of a course of home study in communication engineering. It begins with the fundamental concepts of matter and energy, and goes on to introduce electrical quantities, first in d.c. circuits. After chapters on magnetism, inductance, and capacitance, the author deals with the basic types of a.c. circuit, then network theorems, and finally the elements of valves and cathode-ray tubes. There are worked-out examples illustrating each new step, and every chapter ends with a summary of the main points and a set of exercises. About 50 pages of tables and other reference material, a full index, and answers to the exercises, complete the volume.

The actual writing, unfortunately, can on the whole only be described as slipshod. To quote some typical samples: on p.5 it is stated that "there are lines of force emanating from the proton," but there is no warning that such lines are any less real than the proton. Magnetic field intensity "is generally stated in terms of the number of lines of flux per sq cm at right angles to the magnetic field at any point . . . The ratio of flux density to field intensity is called *permeability*." "The magnetic lines of force encircling each loop of the conductor (in a coil) will move in opposite directions between each loop of the coil." "One *weber* is defined as that change in flux linkage per sec which will induce 1 volt in a single turn of conductor."

Seeing that the book is the second in a series by the same author, the first being on applied mathematics, one might expect a reasonably consistent standard of mathematics. For the most part the author avoids anything but the most elementary algebra, and often develops new ideas with the aid of numerical examples; but on p.130, the reader is switched abruptly over to differential equations as the sole means of understanding the inductive circuit; in the next chapter the analogous capacitive circuit is treated only descriptively; while farther on still four pages are devoted to dodging the calculus in showing how an elementary a.c. generator produces a sinusoidal waveform. Some equations are derived with lengthy explanation; others are stated without a hint of a proof. An example of magnetic circuit calculation, admittedly very approximate owing to the neglect of leakage flux, is worked out to five significant figures. In a diagram of a 5-range milliammeter, the line current is shown as having to pass through all the shunts in series on all ranges. The use of units is thoroughly inconsistent.

Nevertheless, some sections are very good, notably those devoted to circuit networks, in which the treatment of equivalents, circuit theorems, and reactance sketches is simple and clear. With some careful revision of the text the book would admirably fulfil its object.

M. G. S.

Einführung in die Funktechnik

By Friedrich Benz. Pp. 736 + xx with 705 illustrations. Springer-Verlag, Vienna 1, Mölkerbastei 5. Price 78s.

This is the fourth edition of a book first published in 1937; it has been much enlarged and is a very comprehensive and up-to-date text-book of radio engineering. It is divided into five parts, of which the first, consisting of eighteen chapters, is devoted to general foundations, including a.c. principles, rectifiers, transformers, networks, Maxwell equations, modulation, piezo-electricity, dielectric and magnetic materials, etc.

The second part, consisting of seventeen chapters, is devoted to valves of all types, photo-electric cells and cathode-ray tubes. The third part, containing eleven chapters, is devoted to low-frequency amplification, electro-acoustics, microphones and loud speakers. The fourth part, containing seventeen chapters, deals very fully with receivers of all types, while the final part of thirteen chapters deals with generating and transmitting equipment, including magnetrons, klystrons and travelling wave tubes, and also aerials of various types. Every branch of the subject is dealt with both theoretically and practically with many photographs showing details of the actual apparatus.

The reader is assumed to have reached a reasonable standard of mathematical ability; already at page 11 Fourier analysis is applied to various waveforms, including the saw-tooth. The system of units employed is the rationalized system introduced by Mie, in which the practical units, the ampere and volt, are used, but the cm is maintained as the unit of length. There is no reference to Giorgi or to the m.k.s. system. The unit of H is the ampere-turn per cm, the unit of B the weber per cm^2, that of permeability the henry per cm and that of permittivity the farad per cm. There is no doubt that in many ways the cm is preferable to the metre as the unit, especially when dealing with current and flux densities. As we pointed out when discussing this system in the editorial of November 1948, since the unit of force is the joule per cm, which is 100 newtons, the unit of mass is necessarily 10 tons or 10^7 grams. The unit of force is also stated to be equal to 10.2 kp, i.e., 10.2 kiloponds, where a kilopond is the force equal to the weight of 1 kilogram.

We were interested to see the Edison cell referred to as the steel accumulator "because it is usually contained in a steel case," and Fig. 1 is stated to give discharge curves of lead and steel accumulators.

The book contains a great number of references which will make it valuable to a radio engineer. At the foot of nearly every page references are given to publications dealing with the subject under discussion. It is a pity that a little more care was not taken in the initials and spelling of names: J. J. Thomson becomes J. L. Thomson, J. A. Fleming becomes L. Fleming, Espley and Oatley become Esplay and Oetley and Kennelly becomes Kenelly, but these things are difficult to avoid in such a large number of references in a foreign language.

Fig. 362, which is supposed to show the nature of the electric field in the neighbourhood of a radiating aerial, is entirely wrong, and the treatment of the subject is very unsatisfactory. This may be partly due to the strange arrangement whereby reception, amplification, etc., are all dealt with before the generation and radiation of electromagnetic waves, which are reserved for the final section of the book.

Although there are over 700 pages, the author points out in the preface that, owing to the enormous development of the subject during the last ten years, it is only possible to give the more important principles of many of the newer developments, and that, in accordance with its title, the book must be regarded as an introduction. As mentioned above, however, references are always given to more detailed publications, and the book is intended to be not only a text-book for students but a reference book for the practising radio engineer. Although it contains such a large amount of material, it omits some things that a student will want to know; for example it gives formulae for the inductance of a straight piece of wire of length l and diameter d, but gives no proof of the formula or explanation of what is meant by the inductance of such a piece of wire. The same is true of the inductance of two parallel wires; the formula is given but not a word of proof or explanation, nor any reference to a book on the subject. It may be maintained, however, that the student should have obtained this information from other sources before commencing the study of radio-engineering.

The book is very well produced; paper, printing, and diagrams are all excellent.

G. W. O. H.

Die Elektromagnetische Schirmung in der Fernmelde— und Hochfrequenztechnik. (Electromagnetic Screening in Telecommunications and High Frequency Engineering)

By Dr. Heinrich Kaden. Pp. 274 + viii with 132 illustrations. Springer-Verlag, Mölkerbastei, 5, Wien 1, Austria.

The author is a well-known authority on this subject; he has been for many years in the laboratories of Siemens and Halske and has devoted himself specially

to the study of screening. Although he has published many papers on the subject the book contains much that has not been published. As far as possible the contents are arranged in order of difficulty.

The book is divided into two parts; the first part deals with screening against interfering fields, and the second part with screening against interfering currents in multi-core cables. An introductory section is devoted to the Maxwell equations in Cartesian, cylindrical and spherical coordinates, and at the end of the book there is an appendix with the more important properties of the cylindrical and spherical functions which enter largely into many of the screening problems. The opening section also deals with the depth of penetration and equivalent thickness of the conducting layer due to skin effect. The first chapter deals with closed screens with homogeneous walls, first with the disturbing magnetic field outside the screen and then with it inside the screen, with single screens and with screens of several layers of different metals. The second chapter deals with screens that have breaks in the metallic continuity in various directions, but no openings; screens with definite openings and gaps are dealt with in the third and fourth chapters. The fifth chapter deals with the electric and magnetic screening effect of grids and networks. The second section of the book is devoted to screening against cross-talk due to currents in neighbouring cores in telephone cables of various constructions.

The treatment throughout is very thorough and necessarily of a mathematical character as many of the problems involve Bessel and Hankel functions. The bibliography contains 49 references to papers on the subject.

Fig. 10 is somewhat puzzling until one realises that it is upside down. The word 'rekis' under Fig. 68 should be 'kreis'; there have been several accidents with the type on the same page, and on p. 269 there is a reference to a paper on the 'industance and retisance' of coils. These are minor details, however, and the book is undoubtedly a valuable addition to the literature on this subject.

G. W. O. H.

Graphical Symbols for Telecommunication—Component References.

Supplement No. 1 (1950) to British Standard 530: 1948. Pp. 12. British Standards Institution, 24/28 Victoria St., London, S.W.1. Price 2s.

Previous editions of B.S.530 have not contained any directions for identifying components in a diagram. In the 1948 edition it was stated that the matter was being discussed among interested parties. Difficulties were due to the different methods adopted by telephone engineers on the one hand and radio engineers on the other, but the increasing intermingling of telephone and radio circuits made it necessary to come to some agreement. The result is a compromise, reducing to a minimum the changes to be made in each system.

Components are divided into two classes:—(a) Switches, relays and similar devices, and (b) All other components.

All components are designated by one or more letters; several similar components are distinguished in class (a) by the addition of A, B, C etc. and in class (b) by the addition of 1, 2, 3, etc. Thus, three switches would be SWA, SWB, and SWC, whereas three transformers would be TR1, TR2, and TR3. If the switch SWB has several contact units they will be SWB1, SWB2, etc., whereas in class (b) if the transformer TR2 has several terminals, they will be TR2a, TR2b, etc. It seems a pity that a common system could not be adopted for both classes.

The supplement contains tables giving the designations of the various components, and the class, to which they belong. Some are mandatory, some optional, and permissible exceptions are explained.

G. W. O. H.

Glossary of Terms used in Radar.

Supplement No. 4 (1950) to British Standard 204: 1943. Pp. 12. British Standards Institution, 24/28 Victoria St., London, S.W.1. Price 2s.

The 1943 'Glossary of terms used in telecommunication' is naturally incomplete in those fields in which there has been great development in recent years. A number of supplements are being issued dealing with the terms used in these fields. In this supplement the first section deals with nine terms that are not peculiar to radar, and the second section with forty-nine terms that apply only to radar. In some cases a number (in one case five) of deprecated alternative terms are given. To anyone not well acquainted with the subject, some of the terms, such as snow, grass, jitter and clutter will seem strange, but it is important that those who are engaged in radar operation training and research should know the exact meaning of the various terms and also which to employ when there are several alternatives.

G. W. O. H.

Radio Servicing

By Abraham Marcus. Pp. 775 + xxi. George Allen & Unwin Ltd., 40, Museum St., London, W.C.1. Price 35s.

This book covers elementary theory as well as servicing. It is of American origin and so the apparatus taken as examples and, in particular, the test equipment described, are all of American type.

Radio Laboratory Handbook

By M. G. Scroggie, B.Sc., M.I.E.E., 5th Edition. Pp. 430 with 215 illustrations. Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1. Price 15s.

Theory and Application of High Frequency Phenomena

Edited by Y. Asami. Pp. 68. Research Institute of Applied Electricity, Hokkaido University, Sapporo, Japan.

Electronic Engineering Master Index, 1949

Pp. 296 + xvi. Electronic Research Publishing Co. Inc., 480, Canal St., New York 13, U.S.A. Price $17.50.

Air Compressors

By P. C. Bevis. Pp. 192 + vii with 87 illustrations. Sir Isaac Pitman & Sons Ltd., Kingsway, London, W.C.2. Price 20s.

The Patents Act 1949

Pp. 327. Sweet & Maxwell Ltd., 2 and 3, Chancery Lane, London, W.C.2. Price 37s. 6d.

ELECTRICAL TECHNICIANS

The Institution of Electrical Engineers has published a report on "The Education and Training of Electrical Technicians," which is obtainable from the Institution, Savoy Place, London, W.C.2. Price 1/-. The report is that of a committee appointed by the Council of the British Electrical & Allied Manufacturers' Association, The Radio Industry Council, and the Council of the I.E.E.

ABSTRACTS and REFERENCES

Compiled by the Radio Research Board and published by arrangement with the Department of Scientific and Industrial Research

The abstracts are classified in accordance with the Universal Decimal Classification. They are arranged within broad subject sections in the order of the U.D.C. numbers, except that notices of book reviews are placed at the ends of the sections. U.D.C. numbers marked with a dagger (†) must be regarded as provisional. The abbreviations of the titles of journals are taken from the World List of Scientific Periodicals. Titles that do not appear in this List are abbreviated in a style conforming to it.

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FIRST GROUP

ACOUSTICS AND AUDIO FREQUENCIES

534.232 2112

The Production of Edge Tones by Circular Gas Jets and Plane Laminae.—H. von Gierke. (*Z. angew. Phys.*, March 1950, Vol. 2, No. 3, pp. 97–106.) An experimental investigation and discussion of the theory of the production of edge tones at a hole or slit in a lamina directly above a jet of gas. Stroboscopic observations of the jets under such conditions indicate that the tones are due to the periodic whirls of the issuing gas. Frequency measurements were made for different lamina spacings and different velocities and diameters of jet. The properties of edge-tone devices as radiators of sound energy are considered.

534.26 + 535.421 2113

The Diffraction of a Plane Wave through a Grating.—Miles. (*See* 2179.)

534.26 2114

On Two Complementary Diffraction Problems.—A. Storruste & H. Wergeland. (*Phys. Rev.*, 1st June 1948, Vol. 73, No. 11, pp. 1397–1398.) Spheroidal coordinates are introduced for obtaining exact solutions for the diffraction of sound waves by a circular disk and by a hole in an infinite plane screen. The electromagnetic case is to be dealt with later.

534.321.9 : 534.133-14 2115

Theoretical and Experimental Investigations of the Oscillations and the Radiation Resistance of an Ultrasonic Quartz Crystal.—G. Bolz. (*Z. angew. Phys.*, March 1950, Vol. 2, No. 3, pp. 119–127.) The differential equations are derived for the 3-dimensional motion of a quartz crystal oscillating in a liquid. An approximate solution is given, assuming plane oscillations, and expressions are derived for radiation resistance, amplitude of oscillations, decrement, and equivalent-circuit values near resonance. The mean value of radiation resistance found by measuring the damping effect on an oscillatory circuit agrees with the theoretical expression. Deviation (generally $<10\%$) of the measured value from the mean is attributed to an unknown form factor, the assumption of plane oscillations being only an approximation to the actual conditions. Values given for equivalent L and C are valid for a crystal oscillating in air or in vacuo.

534.321.9 : [534.373 + 534.22 2116

A New Frequency-Modulation Method for Measuring Ultrasonic Absorption in Liquids.—E. Ribchester. (*Nature, Lond.*, 17th June 1950, Vol. 165, No. 4207, p. 970.) The output from a r.f. oscillator, modulated by a sinusoidal a.f. voltage, is applied to a quartz transducer. The a.f. voltage is also passed through a variable-phase-shift network and modulates a second oscillator on a different radio frequency. The output from this oscillator is injected into a frequency changer together with the signal from the receiving transducer in the liquid cell, and the phase-shift network is adjusted for maximum output from the frequency changer, corresponding to absence of frequency modulation. Results of measurements of absorption in water, using a frequency of 10 Mc/s, are in close agreement with those obtained by pulse techniques.

534.6 : 621.395.632.11 2117

Acoustical Study of Telephone Bells of the French P.T.T. Administration.—In 1325 of June please insert as authors P. Chavasse & R. Lehmann.

534.86 2118

Listeners' Sound-Level Preferences : Part 2.—T. Somerville & S. F. Brownless. (*B.B.C. Quart.*, Spring 1950, Vol. 5, No. 1, pp. 57–64.) A description of tests on listeners' preferences for changes in sound level between the end of one programme and the beginning of the next. The results are summarized for various programme changes; a reduction of 4–5 db is preferred for speech following music, and an increase of about 2 db for music following speech. Part 1: 1266 of 1949.

621.395.61 + 621.395.623.7] : 597.08 2119

Underwater Sound Technique in the Service of Modern Research.—H. Gemperle. (*Radio Tech., Vienna*, May 1950, Vol. 26, No. 5, pp. 235–239.) Description and theory of pressurized transmitter and microphone units for depths up to 30 m. The frequency range 30 c/s–20 kc/s is covered with good efficiency.

621.395.623.7 2120

Study of Different Acoustic Baffles for Loudspeakers.—T. S. Korn. (*Toute la Radio*, June 1950, Vol. 17, No. 146, pp. 183–186.) Analysis of the general theory of sound radiation from loudspeakers and discussion of different basic types of baffle. The simplest effective construction for even response is the bass reflex baffle consisting of a closed cabinet lined with absorbent material, with an orifice beneath the loudspeaker. The labyrinth-type baffle gives a similar response curve.

621.395.625.3 : 621.3.018.78† 2121

Overall Frequency Characteristic in Magnetic Recording.—P. E. Axon. (*B.B.C. Quart.*, Spring 1950, Vol. 5, No. 1, pp. 46–53.) Frequency distortion in magnetic recording is discussed and illustrated by calculated and measured characteristic curves. The frequency characteristic of the record on the tape can be determined independently of the reproducing-head characteristic by using a reproducing head with a wide gap. The magnitude of self-demagnetization in commercial tapes can be evaluated by this method, and the results obtained can be used in conjunction with the calculated characteristic of a normal reproducing head to predict the response of magnetic recording equipment.

621.395.665.1 2122

The Electrodynamic [volume] **Expander.**—(*Radio Tech. Eng., Édn franç.*, April & June 1950, Vol. 4, Nos. 2 & 3, pp. 116–124 & 177–181.) Based on an article in Italian by Zanarini. The principles of a simple and economical expansion circuit are described in which the moving-coil loudspeaker serves as the expander, the current through the field coil being controlled in accordance with the amplitude of the a.f. signal applied to the moving coil. No distortion is introduced by this method and the amplifier chain needs no modification. The basic circuit consists of a transformer with primary across the moving coil; the output from the secondary is rectified and applied across a parallel RC circuit to the grid and cathode of a pentode which has the field coil in its anode circuit. Developments of the circuit are discussed and practical considerations are summarized.

621.396.645.029.3 2123

A.F. Amplifiers.—R. Besson. (*Toute la Radio*, May & June 1950, Vol. 17, Nos. 145 & 146, pp. 167–171 & 187–191, 199.) Three classes of amplifier are considered: (*a*) high-quality; (*b*) a compromise of quality and cost; (*c*) the cheapest with satisfactory performance. Design considerations and details of ancillary circuits are discussed. A 4.5-W and a 10-W amplifier of class (*b*) are treated as examples and simple calculations made to determine their design specifications. Complete circuit diagrams and notes on construction and testing are included.

AERIALS AND TRANSMISSION LINES

621.315.212 : 621.317.336 2124

Study of the Impedance Irregularities of Coaxial Cables by Oscillographic Observation of Pulse Echoes.—P. Herreng & J. Ville. (*Ann. Télécommun.*, Oct. 1948, Vol. 3, No. 10, pp.317–331.) See 2162 of 1948 and 142 of 1949 (Couanault & Herreng).

621.392 2125

Phase Distortion in Feeders: Effect of Mismatching on Long Lines.—L. Lewin, J. J. Muller & R. Basard. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 143–145.) A fresh approach to the problem of transmitting t.m. signals along feeder lines is made by considering the system as supporting a series of progressive waves of various instantaneous frequencies and reflected within the confines of the feeder. The production of phase distortion and harmonics is analysed and an example of transmission along a waveguide is worked out.

621.392 2126

Study of a System of Two Parallel Wires by the Method of Hallén.—V. Belevitch. (*HF, Brussels*, 1950, No. 6, pp. 163–168.) An integral equation, analogous to that of Hallén for an aerial, is established for a bifilar line. The first-approximation solution of this equation corresponds with the results given by the classic theory of transmission lines. The second approximation takes account of end effects and of radiation. The expression obtained for the radiated power coincides with that derived by C. Manneback by another method.

621.392.26† 2127

The Field Generated by an Arbitrary Current Distribution within a Waveguide.—J. J. Freeman. (*Bur. Stand. J. Res.*, Feb. 1950, Vol. 44, No. 2, pp. 193–198.) Formulae are derived for waveguides of rectangular, circular and coaxial cross-section by extending expressions previously obtained for cavities (2762 of 1948) to the case of infinite length. As a check on the formulae it is shown that the value given for the field from an axially directed dipole within a circular guide reduces to the free-space value when the radius becomes infinite.

621.392.26† 2128

Reflection Cancellation in Waveguides.—L. Lewin. (*Elect. Commun.*, March 1950, Vol. 27, No. 1, pp. 48–55.) Reprint. See 3037 of 1949.

621.392.26† : 621.396.67 2129

Slotted Waveguides and their Applications as Aerials: Part 1.—J. Ortusi & G. Boissinot. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 94–108.) Theory is given based on the elementary concept of the reflection and transmission coefficients of a slot. From consideration of a single slot in (*a*) an infinite conducting plane, (*b*) a waveguide wall, general formulae are derived for the radiation from a waveguide having n equal and equidistant slots. The relations are applied to waveguides with $\lambda/2$ and with $\lambda/4$ spacing of slots, which radiate respectively with constant amplitude and with exponentially decreasing amplitude. Formulae which determine the conditions of use of slotted waveguides and their operating bandwidth are deduced.

621.392.5 2130

Note on Artificial Delay Lines.—G. Martin. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1645–1647.) A method of calculation more exact than hitherto used is developed for a line consisting of a helically wound wire on an insulated cylindrical metal core, by considering the planar transformation in which the system is cut lengthwise and opened out. The method applies particularly to the case when the dielectric layer is thin and the pitch of the winding and the core curvature are small, and permits evaluation and correction of nonuniformity effects at the end of the line. Measurements by various methods agree with the calculated results to within a few per cent.

621.396.67 2131

The Principle of Conservation of Energy and Kottler's Formulae.—J. Ortusi & J. C. Simon. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 67–73.) Application of Kottler's formulae to the radiation from a waveguide aperture shows that, considering a waveguide of infinite length, the law of energy conservation and Maxwell's equations are satisfied simultaneously only by an existing field. For an arbitrary field to satisfy the energy condition, the reflected wave must be introduced. In a waveguide of rectangular cross-section the reflected wave tends to a zero value as the frequency is increased without limit. A rigorous proof of this is given.

621.396.67 2132

An All-Band Mobile Antenna System.—S. S. Perry. (*QST*, June 1950, Vol. 34, No. 6, pp. 16–18.) Details of a combination covering the wavelength range 2–160 m. For wavelengths of 2, 6 and 10 m a $\lambda/4$ whip aerial mounted high on the vehicle is used. For longer waves an aerial centre-loaded with a multitapped coil is substituted. This serves as a $\lambda/4$ aerial for 10.7-m wavelength when all the coil is short-circuited, and resonates at 3.5 Mc/s (85.7 m) when about 160 turns of the coil are in use. For wavelengths up to 160 m a second loading coil is added in series.

621.396.671 2133

Indoor Measurement of Microwave Antenna Radiation Patterns by means of a Metal Lens.—G. A. Woonton, R. B. Borts & J. A. Carruthers. (*J. appl. Phys.*, May 1950, Vol. 21, No. 5, pp. 428–430.) Laboratory measurements were made using a metal lens to render the spherical wave-front plane, the method being similar to that used in optical diffraction measurements. Comparison of results with those obtained by standard field methods showed little loss of accuracy for angles between $-15°$ and $+15°$ for horns of aperture width 32 cm, using a lens of aperture 110 cm and a wavelength of 3.2 cm. A stepped lens was found unsatisfactory, probably because of diffraction caused by the steps.

621.396.671 2134

Input Impedance of Horizontal Dipole Aerials at Low Heights above the Ground.—R. F. Proctor. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 188–190.) "The large increase in the radiation resistance of a horizontal dipole at low heights above the ground, predicted by the mathematical analysis of Sommerfeld and Renner, is confirmed by actual measurement for the case of an essentially-pure-dielectric ground. Measurements carried out above a series of conducting mats of increasing mesh size corroborate the supposition that the large increase in the radiation resistance at low heights is caused by a corresponding increase in the energy radiated downwards into the dielectric ground."

621.396.671 2135

Gain of Aerial Systems.—P. M. Woodward & J. D. Lawson. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 166.) Comment on 3057 of 1949 and 820 of April (Bell).

621.396.671.011.2 2136

Mutual Impedance and Self-Impedance of Coupled Parallel Aerials.—B. J. Starkey & E. Fitch. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 129–137.) Existing formulae for the mutual impedance of parallel aerials are approximate or based on simplifying assumptions. To check these formulae, the authors measured the front/back ratios of the radiation patterns of 2-element arrays, confirming and extending the observations of McPetrie & Saxton (1450 of 1946). The use of "intrinsic impedance", based on a simple transmission-line calculation, for the self-impedance of each aerial resulted in poor agreement between theory and observation. By introducing resistive losses and end-capacitance in the lines, quite good agreement was obtained.

CIRCUITS AND CIRCUIT ELEMENTS

621.3.011.2 [negative] 2137

Negative-Resistance Characteristics.—A. W. Keen. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 175–179). Negative-resistance characteristics as encountered in practice are qualitatively surveyed, and the distinction between the characteristics resulting respectively from voltage and current control of feedback is emphasized. A method of building up a particular characteristic by synthesis of positive and negative elements is described, the basic positive element being represented very closely by the characteristic of a hard diode. The concept of a "negative diode" is introduced, and an equivalent circuit composed of positive and negative diodes is shown for a triode and discussed also for a tetrode.

621.314.2 : 621.396.645.2 2138

Bifilar I.F. Coils.—S. R. Scheiner. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 104–107.) The use of transformers with the two coils wound together for coupling the various stages of stagger-tuned i.f. amplifiers renders coupling capacitors unnecessary. The low time constant of the grid circuit gives improved signal/noise ratio and the r.f. choke normally used to feed the anode of the final i.f. valve can be omitted. Detailed analysis of circuits including bifilar transformers is presented and their advantages and limitations are discussed.

621.314.3† 2139

Magnetic Amplifiers of the Balance-Detector Type.—W. A. Geyger. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, p. 459.) Summary of 1950 A.I.E.E. Winter General Meeting paper.

621.316.726.078.3 : 538.569.4.029.64 2140

Servo Theory applied to Frequency Stabilization with Spectral Lines.—W. D. Hershberger & L. E. Norton. (*J. Franklin Inst.*, May 1950, Vol. 249, No. 5, pp. 359–366.) Comparison between the frequency of a gas-absorption line and the frequency to be stabilized, or a frequency simply related to it, is made by a sweep-oscillator technique. A pulse is generated each time the resonance frequency is passed through. The resulting voltages are applied to a suitable discriminator, the output from which is fed to a servo system controlling the frequency. The limitations and performance of the circuits involved are discussed. A long-term frequency stability within 1 part in 10^7 has been realized.

621.316.8 : 621.396.822 2141

Noise in Current-Carrying Ohmic Conductors.—B. Meltzer. (*Phil. Mag.*, April 1950, Vol. 41, No. 315, pp. 393–398.) The mean-square noise current in a conductor which is in temperature equilibrium, and carries a current I, is calculated on the assumption that the current is due to elementary carriers of charge e. The value obtained for the spectral density is $\{(2kT/R) + (2kT/R)^2 + (eI)^2\}^{\frac{1}{2}}$ where R, T, k are respectively resistance, absolute temperature and Boltzmann's constant. The interpretation of this result is that, over and above the ordinary thermal Nyquist noise, there is present an additional noise, of which the spectral density varies in square-law fashion according to $(e^2R/kT)I^2$ for small values of I, and in linear fashion according to $\{(-2kT/R) + 2eI\}^{\frac{1}{2}}$ for large values of I. These predictions are compared with Bernamont's experimental results for thin metallic conductors, and the discrepancies are discussed.

621.316.86 2142

Thermistors: Part 1. Static Characteristics.—O. J. M. Smith. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 344–350.) "The fundamental thermistor equations are presented as functions only of electrical quantities and constants, and independent of temperature measurements. The universal curves allow one to predict the static characteristics of thermistors as circuit elements. The two most significant characteristics are the power coefficient of resistance, and the negative incremental resistance. These can be computed, or read from the universal curves, if the resistance and four parametric constants are known. These five values can be determined from six convenient measurements: the resistance and change of resistance with current at very low current, at the maximum voltage point, and at maximum current." Part 2: 2143 below.

621.316.86 2143

Thermistors: Part 2. Dynamic Characteristics.—O. J. M. Smith. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 351–356.) The thermistor sinusoidal and transient response characteristics are presented as functions of the dissipation constant and incremental resistance. Equations are given for time constant, critical frequency, equivalent inductance, and Q. The construction of a low-frequency oscillator is discussed, as well as possible nonlinear-filter applications. Part 1: 2142 above.

621.318.572 2144

Decade Pulse Counter for Geiger-Müller Tubes.—B. Åström. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 323–326.) Full circuit details of a counter with the following features:—direct indication; easily reset to zero; all resistors and capacitors with 10% tolerances; very reliable and insensitive to power-line fluctuations; highly sensitive; components easily accessible; h.v. supply for G-M tube capable of supplying enough current for a quenching circuit of the Neher-Pickering type.

621.318.572 2145

Pentode Counting or Control Ring.—B. L. Moore. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 337–338.) Ten pentodes, Type 6AS6, are used in a very stable counting or control ring whose operation is essentially independent of the amplitude, wave shape, and repetition rate of the incoming pulses, and which does not require careful selection of valves.

621.392 2146

A Useful Network Procedure.—S. C. Dunn. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 171–175.) The method establishes a relation between the parallel and the star connection of quadripoles. Any number of networks in parallel, with common generator and load, can be replaced by a set in star connection, having a common central load, but each having an independent generator. The method is applied to study the steady-state and transient responses of a parallel-T RC network. The use of the method for obtaining the input impedance of multichannel networks is demonstrated, and an example is given of a prism-like system of resistor wires which may be reduced to a network of the separate-generator type.

621.392.4 2147

Transformation of a Lumped-Constant Two-Pole Network to a Dissipative Transmission Line.—A. Millán. (*Rev. Telecomunicación, Madrid*, March 1949, Vol. 4, No. 15, pp. 2–14.) The short-circuited dissipative transmission line whose admittance simulates, over a particular frequency band, the input admittance of a given lumped-parameter circuit, is determined by developing the appropriate irrational function in terms of Mittag-Leffler partial fractions. The graph of the resultant approximately rational function is compared with that of the rational function for the given network, and the transmission-line parameters deduced. Alternatively the lumped-parameter circuit is simulated by a lossless line terminated by a dissipative rod. An illustrative example is calculated.

621.392.43 2148

Matching of Amplifiers and Centimetre-Wave Auto-oscillators over a Wide Band of Frequencies.—M. Denis. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 74–88; *Onde élect.*, June 1950, Vol. 30, No. 279, pp. 271–284.) Typical examples are given of maximum amplifier efficiency and minimum distortion occurring at different frequencies. The advantages of ideal matching in this sense are discussed with particular reference to the klystron amplifier. Matching circuits are described which are derived from band-pass filters or from natural or artificial delay lines. The phase-changing element necessary for an asymmetrical quadripole matching device is analogous to the circuits used in the microwave field. The extension of these principles to self-oscillators and amplifier chains is discussed, the resulting improvement in efficiency and reduction of the number of stages making the sacrifice of simplicity worth while.

621.392.43 2149

Method of Matching a Feeder Line for a Given Frequency.—J. Paris. (*Radio franç.*, June 1950, No. 6, pp. 4–8.) Formulae are derived for finding the positions of the Sterba clip and its short-circuiting link for matching a 2-wire feeder of negligible loss to an aerial or other terminating load. The use of the Sterba diagram and of a cartesian diagram is illustrated by numerical examples.

621.392.43 2150

Graphical Methods for Impedance Matching.—A. F. Huerta. (*Rev. Telecomunicación, Madrid*, March 1949, Vol. 4, No. 15, pp. 15–22.) With special reference to stub matching.

621.392.5 2151

A Graphical Approach to the Synthesis of General Insertion Attenuation Functions.—J. M. Linke. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 179–187.) An investigation of methods of constructing the insertion transfer function of a network as a rational function meeting prescribed requirements. The insertion modulus function has been determined approximately by earlier methods of limited usefulness. A new semi-graphical method is described, using template curves on log-log paper. These are selected to fit the required zeros and poles of the numerator and denominator polynomials and are added graphically to give the approximate attenuation curve shape. The method is unsuitable for networks having sharp cut-off regions.

621.392.5 : 621.315.212 : 621.397.743 2152

Equalization of Coaxial Lines.—K. E. Gould. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, p. 390.) Summary of 1949 A.I.E.E. Fall General Meeting paper. Arrangements used for television service are discussed; the measured gain and delay-distortion characteristics for the Washington/Chicago circuit are shown graphically.

621.392.52 2153

Design of Dissipative Band-Pass Filters producing Desired Exact Amplitude-Frequency Characteristics.—M. Dishal. (*Elect. Commun.*, March 1950, Vol. 27, No. 1, pp. 56–81.) Reprint. See 3369 of 1949.

621.392.52 2154

Calculation of Transients in Electrical Filters.—T. Laurent. (*Rev. Telecomunicación, Madrid*, Dec. 1948, Vol. 4, No. 14, pp. 17–28.) Application of the frequency-transformation method noted in 1339 of 1938 to obtain expressions for transients in low-pass and band-pass filters. Translated from *Tekniska Meddelander från Kungl. Telegrafstyrelsen*, No. 2, Aug. 1947.

621.392.52 : 539.2 2155

Physical Basis of the Wave Filter.—Salpeter. (*See* 2197.)

621.392.52 : 621.397.82 2156

The Latest Techniques for the Elimination of Ham TVI.—P. S. Rand. (*CQ*, June 1950, Vol. 6, No. 6, pp. 9–12, 61.) Description of the construction and correct method of fitting low-pass filters in aerial leads for harmonic suppression, together with methods of interference suppression for ignition systems.

621.395.665.1 2157

The Electrodynamic [volume] **Expander.**—(*See* 2122.)

621.395+621.396].813 2158

621.3.018.78† **Distortion.**—Please note that, in this and subsequent issues, the U.D.C. number used will be 621.3.018.78† instead of 621.395.813 and 621.396.813 used hitherto.

621.396.6 : 061.4 2159

Trends in Components.—(*Wireless World*, June 1950, Vol. 56, No. 6, pp. 229–235.) Short account of selected exhibits at the private exhibition organized by the Radio and Electronic Component Manufacturers' Federation and held in London 17th–19th April 1950. A list of the names and addresses of exhibitors is appended.

621.396.611.1 : 517.942.932 2160

Relaxation Oscillations.—LaSalle. (*See* 2261.)

621.396.611.21 2161

Loading Quartz Crystals to Improve Performance.—(*Tech. Bull. nat. Bur. Stand.*, May 1950, Vol. 34, No. 5, pp. 59–62.) Experimental investigation by L. T. Sogn. Examination by means of a probe electrode of the frequency and activity distribution at the surface of a crystal plate led to the detection of differences in thickness of $< 20\ \mu$. Variations in surface activity and frequency for various plates, loaded and unloaded, and during temperature runs from −60°C to +90°C are described. In many cases loading has proved very beneficial.

621.396.611.21.012.8 2162

X-Cut Quartz Crystal.—F. M. Leslie. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 180–181.) "A new equivalent circuit for a crystal driving a mechanical load is devised in terms of an electrical transmission line instead of the usual lumped components of inductance and capacitance."

621.396.615.11 2163

The Calculation of RC Oscillators.—G. Issay. (*Bull. schweiz. elektrotech. Ver.*, 6th Aug. 1949, Vol. 40, No. 16, pp. 509–517. In German.) The basic design principles of RC oscillators are outlined and illustrated by an example in which the calculation for a negative-feedback amplifier is based on that for two simple amplifier stages with negative current feedback, the first stage having a relatively low value of cathode resistance so that feedback to the second stage is reduced. The sharp resonance of the amplifier using a Wien-bridge type of feedback circuit, and two methods of amplitude limiting by means of thermistors, are discussed. Phase-shift oscillators are briefly considered, with particular application to the design of a 3-phase generator.

621.396.615.142.2.018.424† 2164

A Wide Range 600-7 000 Mc/s Local Oscillator.—P. Janis. (*Tele-Tech*, April 1950, Vol. 9, No. 4, pp. 22–24.) The frequency range 600–7 000 Mc/s is covered on c.w. by two reflex klystrons, Types 6BL6 and 6BM6 used in conjunction with an adjustable cavity resonator consisting of a short-circuited coaxial line. Design and construction details are given. For pulsed outputs, Types S.D.-1103 and S.D.-1104 reflex klystrons have been developed; these have similar operating characteristics to the c.w. valves, but have a low-voltage control electrode for taking the input pulses.

621.396.615.17/.18 2165

A Tuned Plate Multivibrator.—A. E. Johanson. (*Bell Lab. Rec.*, May 1950, Vol. 28, No. 5, pp. 208–212.) The difficulty of obtaining short-duration pulses with the conventional multivibrator circuit is overcome by replacing the anode resistors by parallel combinations of varistor rectifiers and tuned circuits, whose resonance frequency then controls the timing. Pulses of duration estimated at 0.02 μs have been produced. A further modification is described for frequency division at high frequencies, e.g., from 18.432 Mc/s to 8 kc/s in four steps.

621.396.615.18 2166

Frequency Division with Phase-Shift Oscillators.—C. R. Schmidt. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 111–113.) Divisions by factors as high as 7 are easily obtainable by means of single-valve RC oscillators using standard components requiring only initial adjustment. Dividers operating from crystal- or tuning-fork-controlled oscillators have been constructed to give accurate 60-c/s outputs. Divisions by 5, 6 and 7 were used in these designs, the locking range for these factors being adequate to ensure reliable operation. Initial adjustment of single-stage scale-of-ten circuits requires more care because of the restricted locking range.

621.396.619.23 2167

Non-Linear Distortion in a Cowan Modulator.—V. Belevitch. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 164–165.) Author's reply to 1552 of June (Tucker & Jeynes).

621.396.645 2168

A New Amplifier, the "Cathode Repeater".—V. J. Cooper. (*Marconi Rev.*, 1950, Vol. 13, No. 97, pp. 72–80.) The use of a triode with the cathode as the signal input terminal has certain advantages for wide-band amplifiers. Under different conditions its input impedance may be purely resistive or may have a positive or negative susceptance. The circuit described can amplify from a low-impedance input into a low-impedance output, with considerable control of the values of input and output impedance.

621.396.645 2169

Differential Amplifiers.—D. L. Johnston. (*Wireless Engr*, June 1950, Vol. 27, No. 321, p. 194.) Comment on 1636 of July (Parnum).

621.396.645 2170

Amplifier with Negative-Resistance Load.—D. M. Tombs & M. F. McKenna. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 189–193.) Stage gains up to 2.5μ (where μ is the valve amplification factor) have been obtained with a triode amplifier loaded with a negative-resistance element. The restrictions imposed on the operation of this type of amplifier by considerations of stability, and the limitation of the gain due to the capacitance of the load are discussed.

621.396.645 + 621.396.621] : 621.385 2171

Electronic Valves : Books II-IV. [Book Review]—(*See* 2388.)

621.396.645 : 621-3.015.3].012 2172

Transient Response Calculation.—J. E. Flood. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 182–188.) The response of various types of n-stage amplifier circuits may be expressed in terms of the Poisson exponential probability summation. Values of this function are already available in tables and charts. Examples are given of its use in analysis of single-stage amplifiers with resistance or LC coupling, and of multi-stage amplifiers with RC or filter coupling or with critically damped inductance compensation.

621.396.645.018.424† 2173

Stagger Gain Calculator.—E. R. Jenkins. (*Tele-Tech*, April 1950, Vol. 9, No. 4, p. 29.) Graphs are presented for determining the optimum number of stages required in a wide-band amplifier of specified characteristics.

621.396.645.35 2174

A D.C. Amplifier for Biological Application.—P. O. Bishop & E. J. Harris. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 365–377.) A four-channel high-gain direct-coupled amplifier is described, with an input impedance >100 MΩ at 10 kc/s. The frequency response is flat from zero to over 10 kc/s. Alternative capacitor coupling is provided so that large-amplitude very-low-frequency noise may be eliminated. When direct coupled the zero shift is of the order of 100 μV peak to peak over a period of 30 minutes.

621.396.645.37 : 621-526 2175

Feedback Amplifiers and Servo Systems.—E. E. Ward. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 146–154.) The pattern of poles and zeros of the response function is considered as a basis for classifying and studying these

devices; this avoids discrimination between the frequency and transient responses, and the Laplace transform is used to develop a broad theory which includes both as special cases. The analysis is restricted to linear systems having lumped constants and one closed loop. A tentative classification of response functions on this basis is tabulated.

621.396.645.371 2176

Some Considerations in the Design of Negative-Feedback Amplifiers.—W. T. Duerdoth. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 138–155. Discussion, pp. 155–158.) "A brief survey is made of the application of a phase-amplitude theorem, due to Bode, to the design of feedback amplifiers with constant-phase margins, and a graphical method of estimating the phase change at any frequency from a knowledge of the amplitude characteristic is described. The use of constant-phase margin as a design criterion is criticized, and justification is given for a new criterion termed 'stability margin'. Using this criterion, a technique is developed for employing several feedback paths, thus enabling an increased amount of feedback to be connected to circuits of increased complexity. A brief account of a miniature audio amplifier with two feedback paths is included, and a 100-watt amplifier covering 300 c/s–108 kc/s with some 35 db of feedback is described which, although it is 'conditionally' stable, is suitable for use in a multichannel telephony system."

621.392.52 2177

An Introduction to the Theory and Design of Electric Wave Filters. [Book Review]—F. Scowen. Publishers: Chapman & Hall, London, 2nd edn 1950, 188 pp., 18s. (*J. Brit. Instn Radio Engrs*, May 1950, Vol. 10, No. 5, p. vi.) First published in 1945, this book "has already established itself as a work of major importance" in its field. A new section now added describes Darlington's insertion-loss method of filter design.

GENERAL PHYSICS

53 2178

Heaviside's Unpublished Notes.—(*Electrician*, 26th May 1950, Vol. 144, No. 3754, p. 1749.) Report of a paper 'Some Unpublished Notes of Oliver Heaviside', by H. J. Josephs, given at one of the I.E.E. Heaviside Centenary Commemorative Meetings, May 1950. The documents in the possession of the I.E.E. show that the fourth volume of 'Electromagnetic Theory' was to contain an account of his ideas concerning the transformation of matter and energy on the atomic scale, together with his integration of the electrodynamics of Clerk Maxwell with the thermodynamics of Willard Gibbs. He extended his conception of 'energy-tubes' to include their condensation into electronic particles. Other notes deal with the particle-like structure of electromagnetic pulses and the correlation of electromagnetism with gravitation.

534.26 + 535.421 2179

The Diffraction of a Plane Wave through a Grating.—J. W. Miles. (*Quart. appl. Math.*, April 1949, Vol. 7, No. 1, pp. 43–64.) The problem of diffraction and scattering of a normally incident plane wave of sound by an infinite plane grating consisting of infinitely thin, coplanar, equally spaced strips with parallel edges is solved. The solution is extended to deal with e.m. waves incident on a grating, the elements of which are perfectly conducting at r.f. or perfectly reflecting at optical frequencies. The case when the screen elements are of finite thickness t is also considered and an approximate solution is obtained including only first-order terms in t/λ.

534.26 + 535.42 : 517.564.4 2180

The Oblate Spheroidal Wave Functions.—Leitner & Spence. (*See* 2259.)

535.37 : 548.0 2181

On the Mechanism of Phosphorescence in Crystals.—D. Curie. (*J. Phys. Radium*, April 1950, Vol. 11, No. 4 pp. 179–185.) Study of the decay of phosphorescence of long persistence. If the return of electrons to the emission centres is bimolecular, their recapture is favoured and the decay of phosphorescence is retarded. In certain cases, however, the general law of decay still holds.

535.42 2182

Diffraction at a Circular Disk.—W. Braunbek. (*Z. Phys.*, 17th March 1950, Vol. 127, No. 4, pp. 405–415.) The method previously described (2183 below) is applied to the case of a circular disk and to related problems. For the near field at points on the axis a very simple expression is obtained, which agrees with the rigorous solution better than the Kirchhoff approximation. Simple formulae are also derived for the distant field. For the transmission coefficient, on account of mathematical difficulties, no improvement on the Kirchhoff approximation is obtained.

535.42 2183

New Approximation Method for Diffraction at a Plane Screen.—W. Braunbek. (*Z. Phys.*, 17th March 1950, Vol. 127, No. 4, pp. 381–390.) Various approximation methods for diffraction of a scalar wave have been proposed, but none give accurate results for small wavelengths (large ka), since their series converge very slowly when ka is large, a being a linear dimension of the disk or aperture and k the coefficient in the scalar wave equation $\Delta u + k^2 u = 0$. A new approximation method has been developed specially for the case where $ka \gg 1$. Numerical comparison with the rigorous solution for a particular case shows that the new method gives considerably better results than the Kirchhoff approximation down to $ka \approx 1$.

535.42 : 538.56 2184

A More Exact Fresnel-Field Diffraction Relation.—G. A. Woonton. (*Canad. J. Res.*, March 1950, Vol. 28, Sec. A, No. 2, pp. 120–126.) The field close to a radiating aperture is often of interest in radio-optical measurements, but the usual approximations in the Fresnel-field evaluation are generally invalid in this region. The distant field is given with good accuracy by the Fraunhofer relation, and from it the near Fresnel field is obtained by the Fourier-transform method. The analysis applies to rectangular apertures for which the field distribution can be expressed as the product of separate distributions in the two directions. The result is an integral which has not been evaluated in closed form, but which reduces to Fresnel's integral when the appropriate approximations are made.

535.42 : 538.56 2185

On the Diffraction of an Electromagnetic Wave through a Plane Screen.—J. W. Miles. (*J. appl. Phys.*, May 1950, Vol. 21, No. 5, p. 468.) Corrections to paper abstracted in 202 of January.

537.217 2186

Vibration Pressure Hypothesis for Electric Repulsion.—H. B. Dwight. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, pp. 397–398.) Similarity between the equation for the net repulsion between moving charges and the equation for the pressure exerted on one moving body by sound emitted from another is adduced in support of Mackaye's theory that e.s. repulsion is a manifestation of radiation pressure.

537.224 2187

Electrets.—W. F. G. Swann. (*Phys. Rev.*, 15th June 1950, Vol. 78, No. 6, p. 811.) An expression is derived for the potential of an electret assuming that it consists of (*a*) a distribution of semipermanent polarization which decays with time, (*b*) a distribution of surface and volume charge which leaks away and has no relation to the decay of the polarization. Complete mathematical details will be published later.

537.226 2188

The Lorentz Correction in Barium Titanate.—J. C. Slater. (*Phys. Rev.*, 15th June 1950, Vol. 78, No. 6, pp. 748–761.) It is assumed that the ferroelectric behaviour of $BaTiO_3$ arises because the Lorentz correction leads to a vanishing term in the denominator of the expression for the dielectric constant. The Lorentz correction is computed for the actual crystal structure and it is found that the local field near the Ti ion is much greater than previously believed, so that even a small ionic polarization of the Ti ions will lead to ferroelectric effects.

537.311.3 2189

The Electrical Conductivity of Thin Wires.—R. B. Dingle. (*Proc. roy. Soc. A*, 23rd May 1950, Vol. 201, No. 1067, pp. 545–560.) Simple approximate methods are first given for evaluating the conductivity of films and wires of a size comparable with the mean free path of the conduction electrons. Rigorous theory for a thin wire is then developed to cover both inelastic and elastic collisions of the electrons at the metal surface. Finally Andrew's recent experimental results for a thin mercury wire are fitted to the theoretical curves obtained, and the mean free path evaluated.

537.311.5 : 621.396.671 2190

Currents on the Surface of an Infinite Cylinder excited by an Axial Slot.—C. H. Papas & R. King. (*Quart. appl. Math.*, July 1949, Vol. 7, No. 2, pp. 175–182.) "The distribution of surface-current density is determined on an axially infinite, perfectly conducting cylinder. A constant distribution of electric field across a narrow axial slot is assumed given."

537.525.029.6 2191

Electron Diffusion in a Spherical Cavity.—A. D. MacDonald & S. C. Brown. (*Canad. J. Res.*, March 1950, Vol. 28, Sec. A, No. 2, pp. 168–174.) The diffusion equation for electrons in a nonuniform field is solved in terms of the confluent hypergeometric function, and the condition for breakdown is derived. Measurements of breakdown fields for uniform electric fields enable the effective characteristic diffusion length to be found. Hence theoretical breakdown curves for nonuniform fields are predicted; these are in agreement with experimental results.

537.562 : 538.561 2192

Radio Emission of Purely Thermal Origin in Ionized Media.—J. F. Denisse. (*J. Phys. Radium*, April 1950, Vol. 11, No. 4, pp. 164–171.) Radiation due to 'hyperbolic' transitions similar to those occurring in the X-ray and γ-ray bands is studied theoretically by an analysis simplified from that of Kramers. By combining classical and quantum theory, a general expression is obtained for the radiation coefficient which is valid in all cases. The corresponding absorption calculated by application of Kirchhoff's theorem agrees with the value obtained from Lorentz's formula, and hence the influence of the refractive index of the medium on the radiations can be studied. Gyromagnetic radiation is briefly discussed.

537.71 2193

The M.K.S. or Giorgi System of Units.—L. H. A. Carr. (*Beama J.*, April & May 1950, Vol. 57, Nos. 154 & 155, pp. 101–106 & 145–147.) A paper given at the I.E.E., in March 1950, putting the case for the adoption of this system. Rationalization is discussed as a separate subject in an appendix.

538.3 2194

Electromagnetic Theory.—(*Electrician*, 26th May 1950, Vol. 144, No. 3754, p. 1750.) Report of a paper 'An Appreciation of Heaviside's Contribution to Electromagnetic Theory', by W. Jackson, given at one of the I.E.E. Heaviside Centenary Commemorative Meetings, May 1950. Heaviside's development of a comprehensive theory of line transmission is not easy to discern from his published work, partly because of repetitions and partly on account of the style, though many of his writings are very clear and the chapter on e.m. waves in Vol. 1 of 'Electromagnetic Theory' is probably the best physical discussion of e.m. wave propagation along telephone lines yet written. Recognition is given to his work in interpreting and extending Maxwell's theory. A partial treatment (published in 1888) of E_{01}-mode propagation within a cylindrical conducting tube is also noted.

539.172.4 : 537.311.33 2195

Transmutation-Produced Germanium Semiconductors.—J. W. Cleland, K. Lark-Horovitz & J. C. Pigg. (*Phys. Rev.*, 15th June 1950, Vol. 78, No. 6, pp. 814–815.) Ge exposed to neutron bombardment becomes a P-type semiconductor due to lattice displacements and to transmutations. The former can be removed by heat treatment and good agreement is then observed for the number of carriers per cm^3 as calculated from cross-sections and as measured by the Hall effect.

539.172.4 : 537.311.33 2196

Fast Neutron Bombardment Effects in Germanium.—J. H. Crawford, Jr, & K. Lark-Horovitz. (*Phys. Rev.*, 15th June 1950, Vol. 78, No. 6, pp. 815–816.)

539.2 : 621.392.52 2197

Physical Basis of the Wave Filter.—J. L. Salpeter. (*Philips tech. Commun., Aust.*, 1950, No. 1, pp. 3–10.) A simple explanation is given of the action of periodic lumped-reactance filters, and the analogy with the behaviour of a row of particles such as atoms in a crystal lattice when irradiated by X rays is demonstrated, the existence of cut-off frequency and stop- or pass-bands being due to the structural discontinuity in both cases. A brief discussion of the 'zone' theory of solids is included. The exponential electrical line is an instance where the existence of a cut-off frequency is not an indication of discontinuous structure.

501 : 512.9 2198

Calcolo Tensoriale e Applicazioni. [Book Review]—Finzi & Pastori. (*See* 2268.)

537.226 2199

Time Dependence of Electronic Processes in Dielectrics. Technical Report Reference L/T219. [Book Review]—H. Fröhlich & J. O'Dwyer. Publishers: British Electrical and Allied Industries Research Association, London, 1949. 8 pp., 4s. 6d. (*Beama J.*, May 1950, Vol. 57, No. 155, p. 151.)

537.71 2200

The M.K.S. System of Electrical and Magnetic Units. British Standard No. 1637. [Book Review]—Publishers: British Standards Institution, London, 1950, 8 pp., 2s. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 167–168.) A summarized record of decisions taken by the International Electrotechnical Commission, expressing no opinions either for or against the system. The question of rationalization is not discussed.

538.1 2201

Die Maxwellsche Theorie in Veränderter Formulierung. [Book Review]—L. Kneissler. Publishers: Springer Verlag, Vienna, 51 pp. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 167.) A suggested modification of Maxwell's theory. "By eliminating magnetism and replacing it by the currents that produce it within the material . . . Maxwell's theory is brought into agreement with the electron theory in its macroscopic form." The book is a development of articles published in *Archiv für Elektrotechnik* in 1940–1942.

538.1 2202

Magnetism. [Book Review]—D. Shoenberg. Publishers: Sigma Books, London, 1949, 216 pp., 10s. 6d. (*Nature, Lond.*, 1st July 1950, Vol. 166, No. 4209, p. 5.) "None of the essential theory of elementary magnetism is omitted, but it appears in a guise less formidable and more convincing than usual." "The book is of a more advanced character than most of the Sigma series and it should be useful to the serious student as well as to the general reader."

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

521.15 : 538.12 2203

A 4-Dimensional Generalization of Wilson's Hypothesis.—A. Papapetrou. (*Phil. Mag.*, April 1950, Vol. 41, No. 315, pp. 399–404.) "Wilson's hypothesis of electric currents accompanying the rotation of electrically neutral matter (in order to explain the origin of the geomagnetic field) is generalized in a 4-dimensional language. The main consequences of the generalized formulation are discussed."

521.15 : 538.12 2204

Magnetism and the Rotation of Celestial Bodies.—A. E. Benfield. (*Nature, Lond.*, 1st July 1950, Vol. 166, No. 4209, p. 31.) The difference between (a) the predictions based on Fermi-Dirac statistics and (b) the requirements of the charge-separation theory of Berlage (1139 of May) is so great that it is hard to see how terrestrial magnetism can be due to this effect to any appreciable extent.

521.15 : 538.12 2205

The External Gravitational and Electromagnetic Fields of Rotating Bodies.—G. L. Clark. (*Proc. roy. Soc. A*, 23rd May 1950, Vol. 201, No. 1067, pp. 488–509.) An electromagnetic field of the form proposed by Blackett is shown to be possible, but the analysis does not rule out the possibility that alternative fields may also satisfy the conditions.

523.74 2206

A Particularly Intense Solar Flare.—R. Müller. (*Naturwissenschaften*, March 1950, Vol. 37, No. 6, p. 137.) Details of observations at Wendelstein Observatory on 19th November 1949.

523.746 2207

Origin of Sunspots.—D. H. Menzel. (*Nature, Lond.*, 1st July 1950, Vol. 166, No. 4209, pp. 31–32.) A new theory is suggested, based on the assumption of a solar general magnetic field of polar intensity several gauss, i.e. 10–20 times less than usual estimates. Ionized gas ejected from the poles returns to the surface near the equator, producing intensification of the magnetic field. Collapse occurs when the gravitational acceleration exceeds the buoyancy effect of the magnetic field; sunspots may then result. Details of the theory are to be given later.

523.746 2208

On the Interpretation of the Sunspot Cycle.—W. Grotrian. (*Naturwissenschaften*, April 1950, Vol. 37, No. 7, p. 163.) Extension of Schwarzschild's calculation of the period of a star to the case of the sun gives values of 9 and 18 years for the solar cycle, when the general field strength is taken as 3 000 gauss. A combination of the Alfvén-Walén (3469 and 3470 of 1945) and Schwarzschild theories offers a conclusive explanation of the sunspot cycle as the period of electromagnetic-hydrodynamic or plasma oscillation of the sun's disk.

550.381 2209

The Effect of the Compressibility of the Earth on its Magnetic Field.—C. Truesdell. (*Phys. Rev.*, 15th June 1950, Vol. 78, No. 6, p. 823.)

551.51 2210

The Stratification of the Atmosphere.—H. Flohn & R. Penndorf. (*Bull. Amer. met. Soc.*, March & April 1950, Vol. 31, Nos. 3 & 4, pp. 71–77 & 126–130.) Suggestions are made for a new classification of atmospheric layers, based on thermal data.

551.510.535 2211

Theory of the Production of an Ionized Layer in a Non-Isothermal Atmosphere, Neglecting the Earth's Curvature, and its Application to Experimental Results.—J. A. Gledhill & M. E. Szendrei. (*Proc. phys. Soc.*, 1st June 1950, Vol. 63, No. 365B, pp. 427–445.) "A new theory of ionospheric layer formation is developed, in which the temperature is assumed to vary linearly with height. The equations are compared at each step with those obtained by Chapman in his theory of layer formation in an isothermal atmosphere. The equations for the maximum of electron density and its height are also given. The effect of the parameters on the shape of the layer is shown in graphical form. The equations are somewhat complex in form, but an ingenious graphical method has been devised suitable for the application of the theory to results given in the form of a Booker and Seaton parabolic distribution of electronic density with height. By application of the theory to mean hourly values for four summer months in South Africa, values are obtained for the temperature gradient, the temperature at 200 km, and its variation over the middle part of the day. The results obtained are in accordance with previous estimates and offer numerical confirmation of the theory that the atmosphere expands bodily upwards during the middle part of a summer day."

551.510.535 : 621.396.11 2212

The Air Force Interest in Sporadic-E Ionization.—N. C. Gerson. (*CQ*, June 1950, Vol. 9, No. 6, pp. 17–19.) An account of co-operation between a band of 425 amateurs in 15 countries and the U.S. Air Force in the study of sporadic-E ionization, particularly regarding the movement of sporadic-E reflection points. The data obtained may be used to advance theories on the mechanism of sporadic-E effects and to form some conception of diurnal, seasonal and annual variations.

551.515.4 : 621.396.9 2213

Radar Measurements of the Initial Growth of Thunderstorm Precipitation Cells.—Hilst & MacDowell. (*See* 2220.)

551.524.7 2214

The Temperature Distribution of the Upper Atmosphere over New Mexico.—A. Nazarek. (*Bull. Amer. met. Soc.*, Feb. 1950, Vol. 31, No. 2, pp. 44–50.) The vertical distribution of temperature was derived, by use of the hydrostatic equation, from pressure data obtained in rocket experiments. The results indicate a steady increase from 210°K at 15 km to 308°K at 55 km, followed by a rapid decrease to 180°K at 85 km and a subsequent increase to 269°K at 120 km. An irregularity occurs at about 100 km, where the temperature decreases slightly, probably owing to dissociation of molecular into atomic oxygen. Seasonal and latitudinal effects are discussed.

551.578.11 2215

The Size Distribution of Raindrops.—A. C. Best. (*Quart. J. R. met. Soc.*, Jan. 1950, Vol. 76, No. 327, pp. 16–36.) Existing experimental data are examined, together with recent measurements in England and Wales, and the results are presented in a common form. Drop-size distribution is regarded as a function of rate of rainfall only, for simplification, and in many cases the distribution is in agreement with simple formulae. Tables based on these formulae are included showing values of the amount of liquid water per unit volume and of the number and total volume of drops, between certain diameter limits, for various rates of rainfall.

551.594.6 + 621.315.59 2216

University Research in Physics.—J. A. Teegan. (*Beama J.*, May 1950, Vol. 57, No. 155, pp. 133–138.) A brief survey of work done and in progress at London University on the nature of atmospherics and on the electrical properties of semiconductors.

551.51 2217

Oscillations of the Earth's Atmosphere. [Book Review]—M. V. Wilkes. Publishers: Cambridge University Press, 1949, 74 pp., 12s. 6d. (*Proc. phys. Soc.*, 1st June 1950, Vol. 63, No. 366B, pp. 459–460.) "This excellent little volume . . . deals with the oscillations produced daily in the atmosphere by the sun and the moon, as revealed mainly by the . . . daily variations of barometric pressure."

551.510.535 : 621.396.11 2218

Short-Wave Radio and the Ionosphere. [Book Review]—T. W. Bennington. Publishers: Iliffe & Sons, London, 2nd edn, 138 pp., 10s. 6d. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 168.) "This book presents the available information on the ionosphere in simple form so that it is usable by non-specialists in the subject. The approach is non-mathematical."

LOCATION AND AIDS TO NAVIGATION

621.396.9 2219

'La Pipologie': the Art of Interpreting the 'Pips' on a Radar Screen.—Vienne & Scotto. (*Radiotech. Dig., Edn franç.*, April 1950, Vol. 4, No. 2, pp. 67–81.) An article on the technique of radar operating, reproduced from a French Service document.

621.396.9 : 551.515.4 2220

Radar Measurements of the Initial Growth of Thunderstorm Precipitation Cells.—G. R. Hilst & G. P. MacDowell. (*Bull. Amer. met. Soc.*, March 1950, Vol. 31, No. 3, pp. 95–99.) Sequence photographs of p.p.i. and r.h.i. (range height indicator) radar presentations are used for measurement of the vertical and horizontal growth of the storm. Vertical growth is rapid and horizontal growth is uniform.

621.396.9 : 551.578.1/.4 2221

The Bright Band — A Phenomenon associated with Radar Echoes from Falling Rain.—J. E. N. Hooper & A. A. Kippax. (*Quart. J. R. met. Soc.*, April 1950, Vol. 76, No. 328, pp. 125–132.) The echoes obtained with vertical transmission are characterized by an intense echo from a layer at a height slightly below the freezing level. This is more pronounced in frontal rain than in instability showers, and is about 5 to 9 times more intense than the echo from the rain below, allowing for difference in range. Experiments are described which establish the height and thickness of the 'bright band' layer. Measurements of the terminal velocity of snow-flakes support Ryde's suggestion that the reduction in echo intensity below the bright band is due to the acceleration of water droplets from their velocity as snow-flakes to the terminal velocity of raindrops.

621.396.9 : 551.578.1/.4 2222

Radar Echoes from Meteorological Precipitation.—J. E. N. Hooper & A. A. Kippax. (*Proc. Instn elect. Engrs*, Part I, May 1950, Vol. 97, No. 105, pp. 89–95. Discussion, pp. 95–97.) A more detailed account of the work referred to in 2221 above.

621.396.9 : 621.385.832 : 535.371.07 2223

Visibility on Cathode-Ray Tube Screens : Positive *vs* Negative Signals on an Intensity Modulated Scope.—Harriman & Williams. (*See* 2386.)

621.396.933 2224

How the C.A.A. Flight Tests V.O.R. Ranges.—A. E. Jenks. (*Tele-Tech*, May 1950, Vol. 9, No. 5, pp. 22–24, 56.) The horizon profile as viewed from the aerial is plotted and course distortion in the shadow area forecast. The station error is obtained by the theodolite check, in which a circular course, with the station as centre, is navigated and plotted. The line-of-sight cut-off point can be deduced by analysis of course-line records obtained by flying aircraft over known test points and courses. Errors in course indication due to instability of the supply voltage frequency, to the presence of vertical polarization in the transmitted signal and to heading effect are measured.

621.396.933 2225

Notes on Radiocommunication Systems for Civil Aviation.—(*Rev. Telecomunicación, Madrid*, March 1949, Vol. 4, No. 15, pp. 47–64.) An account of navigational aids considered at the third [British] Commonwealth and Empire Conference on Radio for Civil Aviation.

MATERIALS AND SUBSIDIARY TECHNIQUES

533.5 2226

On Certain Phenomena of Gaseous Emission observed during the Evacuation of Low-Voltage Incandescent Lamps.—L. Dunoyer. (*Le Vide*, May 1950, Vol. 5, No. 27, pp. 793–806.) Ignition of the filament of 2-V lamps while still connected to the vacuum plant causes an emission of gas which is more rapid and of greater amount, within limits, the longer the time interval between the heating/degassing process and this ignition. This emission was studied with a special thermal micromanometer. It is attributed to adsorbed layers on the walls of the bulb. Immediate sealing after evacuation limits the possibility of subsequent gassing.

535.37 2227

X-Rays in the Development of Inorganic Phosphors.—H. P. Rooksby & A. H. McKeag. (*G.E.C. J.*, April 1950, Vol. 17, No. 2, pp. 89–95.) Greater knowledge of the crystal chemistry of luminescent materials is required both to explain the phenomena of luminescence and to effect improvements in the materials. Identification, crystalline perfection, the effect of changed matrix composition on fluorescence colour, and the role of impurity activators, are among the aspects considered in this survey of the ways in which X-ray analysis has been used in the investigation of phosphor characteristics.

535.37 2228

Trivalent Cations in Fluorescent Zinc Sulphide.—F. A. Kröger & J. Dikhoff. (*Physica, 's Grav.*, March 1950, Vol. 16, No. 3, pp. 297–316. In English.) Incorporation of monovalent cations in a lattice consisting of divalent ions is only possible to an appreciable extent when the lack of positive charge resulting from the substitution of a monovalent cation for a divalent one is compensated. This compensation can be effected by a simultaneous incorporation of monovalent anions, or of cations of a valency higher than two. An explanation can thus be given of the activation of ZnS by monovalent Ag, Cu, Au, Zn when halogens or trivalent cations are present.

Some of the trivalent ions incorporated in this way are found to cause effects of their own (electron traps, fluorescence, killing of fluorescence due to the other centres). An atomic model of the centres of fluorescence is described.

535.37 2229

The Physical Chemistry of the Formation of Fluorescence Centres in ZnS-Cu.—F. A. Kröger & N. W. Smit. (*Physica, 's Grav.*, March 1950, Vol. 16, No. 3, pp. 317–328. In English.)

538.114 2230

Magnetic After-Effect Revealed by means of a Blow.—L. Lliboutry. (*C. R. Acad. Sci., Paris*, 3rd May 1950, Vol. 230, No. 18, pp. 1586–1587.) A light blow may be used instead of a small variation of magnetic field for demonstrating this effect in a steel. See also 1650 of July.

538.22 2231

The α/H Law of Approach [to saturation] **and a New Theory of Magnetic Hardness.**—L. Néel. (*J. Phys. Radium*, May 1948, Vol. 9, No. 5, pp. 184–192.)

538.221 2232

Relation between the Anisotropic Constant and the Law of Approach to Saturation of Ferromagnetic Materials.—L. Néel. (*J. Phys. Radium*, June 1948, Vol. 9, No. 6, pp. 193–199.)

538.221 2233

The Effect of Annealing on the Residual Magnetization of Ferromagnetics.—J. C. Barbier. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1643–1645.)

538.221 2234

Factors Affecting Magnetic Quality.—R. M. Bozorth. (*Bell Syst. tech. J.*, April 1950, Vol. 29, No. 2, pp. 251–286.) The substance of Chapter 2 of a forthcoming book entitled "Ferromagnetism". The effects of chemical composition and methods of production and treatment on the final properties of magnetic materials are discussed. Details of relevant manufacturing processes are included, and lists are given of useful materials and their magnetic properties.

538.221 2235

Thermal Variation of the Coercive Field of Powdered Cobalt.—L. Weil, S. Marfoure & F. Bertaut. (*J. Phys. Radium*, June 1948, Vol. 9, No. 6, pp. 203–207.)

538.221 2236

Antiferromagnetism and Intermittent Activation in Chromium-Iron and Vanadium-Iron Alloys.—R. Forrer. (*C. R. Acad. Sci., Paris*, 3rd May 1950, Vol. 230, No. 18, pp. 1584–1585.)

538.221 2237

On the Conditions for the Occurrence of Ferromagnetism in Metal Compounds.—J. H. Gisolf. (*Physica, 's Grav.*, Sept. 1949, Vol. 15, No. 8/9, pp. 677–678. In English.) Discussion leading to the conclusion that in ferrites (which possess both octahedron holes and tetrahedron holes) only the metal ions in tetrahedron holes can contribute to the ferromagnetism.

538.221 2238

On the Ferromagnetism of Ferrites, or Ferrimagnetism.—L. Néel. (*Physica, 's Grav.*, March 1950, Vol. 16, No. 3, pp. 350–352. In French.) Various experimental results are quoted which indicate that Gisolf's interpretation of the magnetic properties of ferrites (2237 above) is not correct. Néel's theory, on the contrary, is supported by much experimental evidence. See also 1166, 1170 & 1171 of May, and 3159 of 1949.

538.221 2239

Magnetic Properties of a Ferrite of Manganese in Weak Fields.—C. Guillaud & A. Barbezat. (*J. Rech. Centre nat. Rech. sci.*, 1950, No. 11, pp. 83–100.) Description of the method of measurement of different characteristics, particularly l.f. and h.f. losses. Results are presented in tables and graphs.

538.221 : 537.311.33 2240

Experimental Study of the Resistance of Some Semiconducting Ferrites.—C. Guillaud & R. Bertrand. (*J. Rech. Centre nat. Rech. sci.*, 1950, No. 11, pp. 73–82.) Description of method and results of an investigation of Ni, Mn, Mg and complex ferrites between −253° and 800°C. No exceptional characteristics were observed near the Curie point.

538.221 : 621.318.22 2241

Preferred Domain Orientation in Permanent-Magnet Alloys.—M. McCaig. (*Nature, Lond.*, 17th June 1950, Vol. 165, No. 4207, p. 969.) Discussion of possible explanations of the improvement in the magnetic properties of alloys such as alcomax, due to preferred domain orientation. See also 3453 of 1949 (Hoselitz & McCaig).

546.57 : 539.23] : 537.311.31 2242

Current/Voltage Characteristic of Very Thin Films of Silver at High Values of Electric Field.—A. Blanc-Lapierre & M. Perrot. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1641–1643.) Measurements were made at ordinary temperatures with field strengths up to 10 kV/cm, on films of equivalent thickness < 10 mμ vaporized on to glass; marked deviations from Ohm's law were observed. The curvature of the characteristic is mainly due to the lacunal structure of the film, heating effects playing only a minor part. Similar characteristics have been observed for semiconductors and for imperfect metal-point contacts.

548.0 : 535/539 2243

Optical Properties and the Electro-Optic and Photoelastic Effects in Crystals Expressed in Tensor Form.—W. P. Mason. (*Bell Syst. tech. J.*, April 1950, Vol. 29, No. 2, pp. 161–188.) The Fresnel ellipsoid is first derived from Maxwell's equations. The electro-optic and photoelastic effects are then expressed in terms of thermodynamic potentials; methods of measuring them by determining the birefringence in various directions are discussed, and constants are listed for various classes of crystal. The application of the photoelastic effect for measuring strains in isotropic media is considered.

620.197 2244

Tropicalization of some Materials and Assemblies used in the Construction of Valves.—G. Trébuchon. (*Le Vide*, May 1950, Vol. 5, No. 27, pp. 814–818.) Conclusion of paper noted in 1432 of June.

621.315.33 2245

Insulated Sleeving and Covered Wires used on Service Electronic Equipment.—V. G. Hoptroff & G. J. R. Rosevear. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 191–198.) The mechanical and electrical properties desirable in wire-covering material and sleeving are reviewed and standardization is discussed. Summaries are given of interservice specifications. The manufacture and properties of present-day materials are described and their limitations considered. It is suggested that requirements will be more exacting in future. A table is appended of materials suitable for various temperature and voltage ranges.

621.315.59 + 551.594.6 2246

University Research in Physics.—Teegan. (*See* 2216.)

621.315.59 2247

Semiconductive Colloidal Suspensions with Non-Linear Properties.—H. E. Hollmann. (*J. appl. Phys.*, May 1950, Vol. 21, No. 5, pp. 402–413.) The conductivity and dielectric constant of these mixtures (e.g. a fine dielectric powder in oil) depend on the applied electric field; a physical explanation of their properties is given, which is relevant to the general theory of semiconductors. Oscillograms illustrating the nonlinear characteristics of such resistors are shown, and applications are mentioned; the wide range of voltage sensitivity and power dissipation is particularly noted.

621.315.59 2248

On Electrical Conduction in Semiconductors.—F. Stöckmann. (*Naturwissenschaften*, Feb. & March 1950, Vol. 37, Nos. 4 & 5, pp. 85–89 & 105–111.) Discussion of conduction processes inside semiconductors, the barrier layer between semiconductors and metals, and photoconductivity.

621.315.59 : 546.412.64 2249

Study of the Semiconductor Properties of a Natural Calcium Carbonate.—P. Vidal. (*Ann. Phys., Paris*, May/June 1950, No. 5, pp. 257–309.) Experimental and theoretical study of deep-quarried chalk at normal temperatures. Unlike chalk from surface layers, it is relatively pure, has a high resistivity and is a normal semiconductor. Under constant voltage gradient above about 10 V/cm, current intensity decreases with time, tending to a practically constant limit, under which conditions a fall of potential occurs at the cathode. Two methods of determining ion mobility are described. The rectifying property of the substance and the complex radiation of soft X rays which occurs when a mesh-type cathode is used are discussed.

621.315.612.4 2250

Domain Structure and Dielectric Response of Barium Titanate Single Crystals.—B. Matthias & A. von Hippel. (*Phys. Rev.*, 1st June 1948, Vol. 73, No. 11, pp. 1378–1384.)

621.318.22 2251

The Performance and Stability of Permanent Magnets.—A. J. Tyrrell. (*J. Brit. Instn Radio Engrs*, May 1950, Vol. 10, No. 5, pp. 182–191.) The characteristics which contribute to the long-term magnetic stability of a permanent-magnet alloy are considered; present-day anisotropic alloys (e.g. ticonal) embody improvements in all these characteristics. Tests over a period of ten years have proved ticonal magnets to be more stable than materials previously obtainable; they are giving satisfactory service in watt-hour meters, which make high demands on stability. Tables are included giving the performance of numerous British and American commercial alloys.

621.357.8 : 533.5 2252

Electrolytic Polishing and Vacuum Technique.—P. Nineuil. (*Le Vide*, May 1950, Vol. 5, No. 27, pp. 807–813.) Review and discussion of the technique. Its advantages in eliminating surface impurities and reducing gas liberation and 'cold' emission, particularly in X-ray tubes, are stressed.

666.1.037.5 2253

The Physical Aspect of Glass-to-Metal Sealing in the Electronic Valve Industry: Part 1.—G. Trébuchon & J. Kieffer. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 125–149.) From a detailed examination of laboratory results together with experience gained in actual manufacture, specifications are drawn up for quality of seal, annealing cycles and finished-work inspection. Physical and chemical aspects of the sealing process are discussed and a critical survey of methods of test is made.

669.725.3 2254

Beryllium Copper.—J. T. Richards. (*Materials & Methods*, April 1950, Vol. 31, No. 4, pp. 75–90.) The properties, characteristics and available forms of the alloy are described, design considerations and methods of treatment discussed, and applications listed.

535.37 2255

Luminescent Materials. [Book Review]—G. F. J. Garlick. Publishers: Clarendon Press, Oxford, 1949, 254 pp., $5.50. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 386–387.) "... a book which will give a reader with prior knowledge of solid-state physics an opportunity to become acquainted with some of the main characteristics of luminescence in solid materials together with associated descriptive theory in a minimum of time."

666.1.037.5 2256

Glass-to-Metal Seals. [Book Review]—J. H. Partridge. Publishers: Society of Glass Technology, Sheffield, 238 pp., 35s. (*J. sci. Instrum.*, June 1950, Vol. 27, No. 6, p. 175.) "A valuable addition to technical literature."

MATHEMATICS

517.432.1 2257

The Operational Calculus — a Historical Survey of Heaviside's Methods.—(*Electrician*, 26th May 1950, Vol. 144, No. 3754, p. 1751.) Report of a paper given by B. van der Pol at one of the I.E.E. Heaviside Centenary Commemorative Meetings, May 1950. The wide divergence of contemporary estimates of Heaviside's achievements is attributed to the fact that he never gave an exposition of his operational calculus as such; knowledge of it had to be gained by studying the many scattered practical applications in his writings. Modern developments are mentioned, in particular Carson's work in justifying Heaviside's methods by the Laplace transform; Heaviside was aware of this basis to his calculus.

517.432.1 : 621.39 2258

Oliver Heaviside's Operational Calculus.—W. Jackson. (*Electrician*, 19th May 1950, Vol. 144, No. 3753, pp. 1693–1667.) Heaviside's early experiments on problems in telegraphy and the development of his mathematical methods are described.

517.564.4 : [534.26 + 535.42 2259

The Oblate Spheroidal Wave Functions.—A. Leitner & R. D. Spence. (*J. Franklin Inst.*, April 1950, Vol. 249, No. 4, pp. 299–321.) These functions arise in problems such as the diffraction of sound and e.m. waves by circular disks and apertures. Tables published previously by other workers are here extended.

517.942.9 2260

Separation of Laplace's Equation.—N. Levinson, B. Bogert & R. M. Redheffer. (*Quart. appl. Math.*, Oct. 1949, Vol. 7, No. 3, pp. 241–262.) To use the separation-of-variables method in solving partial differential equations, the surface over which the boundary values are specified must coincide with one of the coordinate surfaces, and hence any restriction on the coordinates which can be used is also a restriction on the physical situations to which the method can be applied. The paper is concerned with determining all coordinate systems which are, in this sense, permissible.

517.942.932 : 621.396.611.1 2261

Relaxation Oscillations.—J. LaSalle. (*Quart. appl. Math.*, April 1949, Vol. 7, No. 1, pp. 1–19.) A class of relaxation oscillations related to the equation $d^2x/d\tau^2 + \mu f(x)dx/d\tau + x = 0$ is studied, in which $f(x)$ is not necessarily even. Regions $E(\mu)$ of the phase plane are constructed, each of which contains a single periodic

solution. An introductory example deals with the case of an LCR circuit in which R is nonlinear and nonpassive. The use of a series linear resistance to produce mode separation is mentioned.

519.283 : 621.39.001.11 **2262**

Correlation Functions and Communication Applications.—Y. W. Lee & J. B. Wiesner. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 86–92.) The difference in the forms of the correlation functions for a stationary random process and for a periodic process may be used as a means of separation of the one from the other. The correlation curves are obtained by means of an electronic computer. Among the examples given is the separation of a sinusoidal signal from *random noise* when an input signal/noise ratio of -15 db is changed to an output signal/noise ratio of $+15$ db.

681.142 **2263**

High-Speed Digital Calculating Machines.—J. Bennett. (*Distrib. Elect.*, March & May 1950, Vol. 22, Nos. 179 & 180, pp. 251–255 & 276–280.) A simple account of the historical development and of the operation and capabilities of these machines, illustrated by reference to the EDSAC (see also 3458 and 3459 of 1949). The use of *acoustic delay lines*, special c.r. tubes and magnetic recording devices for storage has helped to make present-day high speeds possible. Costs are examined and applications, both actual and potential, in research and commerce are mentioned.

681.142 **2264**

Linear Equation Solvers.—F. J. Murray. (*Quart. appl. Math.*, Oct. 1949, Vol. 7, No. 3, pp. 263–274.) The set of equations to be solved is of the form

$$\sum_{j=1}^{n} a_{ij}\, x_j = b_i,$$

where $i = 1, 2 \ldots n$. In the type of machine considered, the x_j unknowns are not driven to their correct values by power supplied from the constant inputs, but reach an equilibrium state corresponding to the solution by a process of adjustment. The operating conditions for such a machine are examined for the case in which the adjusting process is determined by a linear operator with constant coefficients.

681.142 **2265**

Pulse Packing in Magnetic Recording Wire.—I. L. Cooter. (*Bur. Stand. J. Res.*, Feb. 1950, Vol. 44, No. 2, pp. 163–174.) An oscillographic method is described for determining the number of magnets per unit length of the recording wire; a powder-pattern method for observing the fields of the individual magnets in a section of wire is also described, with photographs. A comparison was made of the resolution of recorded pulses obtainable with stainless-steel and plated Co-Ni wires. A parameter termed "interference ratio" is defined and used as a criterion of performance. Application is to high-speed digital computers.

681.142 : 533.9 **2266**

Analogue Computer for Flight Simulator.—A. C. Hall. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, p. 433.) Summary of 1950 A.I.E.E. Winter General Meeting paper.

681.142 : 621-526 **2267**

The Electronic Servomechanism Simulator.—C. M. Edwards & E. C. Johnson, Jr. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, p. 411.) Summary of 1950 A.I.E.E. Winter General Meeting paper. The apparatus discussed forms part of a large-scale analogue computer, under development at the M.I.T., for solving the equations of motion of aircraft. See also 2266 above.

512.9 : 501 **2268**

Calcolo Tensoriale e Applicazioni. [Book Review]—B. Finzi & M. Pastori. Publishers: N. Zanichelli, Bologna, 1949. 427 pp., 2000 lire. (*Quart. appl. Math.*, Oct. 1949, Vol. 7, No. 3, p. 352.) "The concepts and principal methods of the tensor calculus are presented in order to facilitate its application by mathematicians, physicists and engineers. The last three chapters deal with applications to (*a*) the mechanics of deformable continua, (*b*) electromagnetic theory, (*c*) relativity theory."

512.972 **2269**

Éléments de Calcul Tensoriel. [Book Review]—A. Lichnerowicz. Publishers: Armand Colin, Paris, 1950, 216 pp., 180 fr. (*J. Franklin Inst.*, May 1950, Vol. 249, No. 5, p. 426.) "The first part comprises an elementary but rigorous presentation of the basic theory both of tensor algebra and tensor analysis. The second part discusses some of the various applications in classical dynamics, electrodynamics and the theory of relativity."

517.53 : 501 **2270**

Introduction to Complex Variables and Applications. [Book Review]—R. V. Churchill. Publishers: McGraw-Hill, New York and London, 1948, 216 pp., $3.50. (*Quart. appl. Math.*, July 1949, Vol. 7, No. 2, p. 240.) "The book should be of interest to those concerned with the use of function theory in engineering problems and similar applications."

517.75 : 621.3.015.3 **2271**

Transformation Calculus and Electrical Transients. [Book Review]—S. Goldman. Publishers: Constable & Co., London, 1949, 440 pp., 30s. (*Beama J.*, May 1950, Vol. 57, No. 155, p. 150.) The book is written for students, but will also be useful for research workers. Stress is laid upon physical interpretations, and detailed solutions are given of many important examples.

517.9 : 501 **2272**

Introduction to the Differential Equations of Physics. [Book Review]—L. Hopf. Publishers: Dover Publications, New York, 1948, 154 pp., $1.95. (*Quart. appl. Math.*, July 1949, Vol. 7, No. 2, pp. 239–240.) "The exposition is clear and concise, and one might like the treatment to go further than it does. The text should be very useful to seniors and beginning graduate students in physics and chemistry."

681.142 **2273**

Giant Brains, or Machines that Think. [Book Review]—E. C. Berkeley. Publishers: J. Wiley, New York, and Chapman & Hall, London, 1949, 270 pp., $4.00. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 385–386.) A primer dealing with a wide variety of computing mechanisms. "A strong anthropomorphic flavor pervades the book . . . It contains a useful bibliography, its descriptions of existing machines probably include some facts unknown to any reader, and the discussions of future possibilities, though incomplete, may be suggestive."

MEASUREMENTS AND TEST GEAR

531-764.5 **2274**

Crystal-Controlled Clock.—(*Bell Lab. Rec.*, May 1950, Vol. 28, No. 5, p. 213.) This instrument was developed as an alternative to the chronometer for use where a portable, accurate standard of time is required. The output of a 1 800-c/s crystal-controlled oscillator is used, after frequency division and amplification, to drive a 60-c/s clock. Correct time was maintained to within 0.22 sec per day over an 8-day period without temperature control; with temperature control the limit of error could be reduced to 0.09 sec per day.

531.764.5 2275

The Performance of the P.T.R. Quartz Clocks and the Yearly Variation of the Length of the Astronomical Day.—A. Scheibe & U. Adelsberger. (*Z. Phys.*, 17th March 1950, Vol. 127, No. 4, pp. 416–428.) Results of time comparisons made from 1934 to 1945 using different types of quartz clock are shown and discussed. Mean daily deviations of the measured time during certain periods are plotted for the different clocks. Observations from 1937, when improved models were brought into operation, confirm the earlier view that the mean daily variation of $\pm 0.001\,5$ sec, which has a yearly period, is due to a variation in astronomical standard time, probably corresponding to an actual change in the rotational velocity of the earth. At summer and winter solstices the variation is zero. In summer the mean measured value is up to 0.12 sec in advance of astronomical time.

538.71 2276

A Saturated-Core Recording Magnetometer.—D. C. Rose & J. N. Bloom. (*Canad. J. Res.*, March 1950, Vol. 28, Sec. A, No. 2, pp. 153–163.) The magnetometer operates on the saturated-core inductor principle, the sensitive element being a strip of high-permeability alloy. An inverse-feedback system supplies a current to neutralize, within 2 or 3 gammas, the field being measured. This current is measured by a recording milliammeter which gives the field directly.

621.317.335.3† : 621.317.372 2277

Measuring Dissipation and Dielectric Constants.—C. F. Miller & F. G. Whelan. (*Elect. Engng, N.Y.*, June 1950, Vol. 69, No. 6, p. 512.) Summary of A.I.E.E. Winter Meeting paper, giving a description of apparatus used in the susceptance-variation method of measuring dissipation factor due to Hartshorn & Ward (351 of 1937). A constant-speed motor-driven capacitor is used to tune the circuit through resonance. A recording milliammeter operated from a valve voltmeter traces the voltage resonance curves. In 5 runs at 24-hour intervals on each of 35 specimens with dielectric constants in the range 3.0–7.3, the deviation from the mean was <0.05 in most cases. For the dissipation factor the deviations were generally $<2\%$.

621.317.336 : 621.315.212 2278

Study of the Impedance Irregularities of Coaxial Cables by Oscillographic Observation of Pulse Echoes.—P. Herreng & J. Ville. (*Ann. Télécommun.*, Oct. 1948, Vol. 3, No. 10, pp. 317–331.) See 2162 of 1948 and 142 of 1949 (Couanault & Herreng).

621.317.336.1 2279

Impedance Measurement.—H. J. Round. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 154–158.) A substitution method is described in which the voltages across the unknown impedance and across a known adjustable resistance R are in turn applied to a c.r.o. A 'swamping' series resistance maintains constant current without introducing unduly high errors. Impedances of 2–300 Ω can be measured over the frequency range 1–150 kc/s. The vector angle is found by connecting a known capacitance in series with the unknown and obtaining a new value of R.

621.317.351 2280

Various Applications of our Low-Frequency Analyser.—R. Aschen & R. Gaillard. (*T.S.F. pour Tous*, May 1950, Vol. 26, No. 259, pp. 170–174.) Oscillograph tracings effected with the instrument described in 2002 of 1948 illustrate the measurement of harmonic distortion, analysis of sawtooth and square-wave signals and their modifications after passing through an amplifier, and analysis of musical sounds.

621.317.444 2281

An Electrostatic Fluxmeter of Short Response-Time for use in Studies of Transient Field-Changes.—D. J. Malan & B. F. J. Schonland. (*Proc. phys. Soc.*, 1st June 1950, Vol. 63, No. 366B, pp. 402–408.) A conducting system of small capacitance is alternately exposed to and screened from the electric field, 1 200 times a second, by a rotating earthed shield, thus producing an alternating e.m.f. of period 0.83 ms. This output is amplified and displayed on a c.r.o. screen and can be recorded photographically. An automatic indication of the sense of the field is provided every 7.5 ms. At maximum sensitivity the instrument gives a deflection of 1 cm in a field of 70 V/m with a background noise level of 3 V/m and has a response time of one half-period (0.42 ms).

621.317.7.087 : 551.594.6 : 621.396.821 2282

On the Recording of the Mean Level of Atmospherics.—F. Carbenay. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1648–1649.) A receiver-recorder has been developed for operation on 27 kc/s. The receiver has a tuned amplifier stage and a diode detector, and the recorder uses a sensitive highly-damped galvanometer. The mean ordinate of the recorded curve is proportional to the product of the amplitude of the impulses and their repetition rate, i.e., the mean field intensity, while the fluctuations about the mean ordinate are proportional to the individual flux impulses. See also 2902 and 3504 of 1948.

621.317.715 2283

An Electromechanism : the Galvanometer.—A. Kaufmann & P. Mériau. (*Radio tech. Dig., Édn franç.*, Feb. & April 1950, Vol. 4, Nos. 1 & 2, pp. 51–61 & 83–39.) A mathematical treatment of the theory of the galvanometer, making use of the operational calculus and of electromechanical/electrical analogies. No new properties are shown, but the introduction of complex or operational electromechanical impedances may be useful for the study of new types of galvanometer.

621.317.72.088.2 2284

Influence of the Ground on the Calibration and Use of V.H.F. Field-Intensity Meters.—F. M. Greene. (*Bur. Stand. J. Res.*, Feb. 1950, Vol. 44, No. 2, pp. 123–136.) The input impedance of receiving aerials varies with height and changing ground conditions. An approximate method is described for calculating this impedance in the case of horizontal dipole aerials over earth having finite values of dielectric constant and conductivity. The effect of changes in ground conditions and aerial terminating impedance on the error of the field-intensity meter is calculated as a function of aerial height. Measured error values are in reasonably good agreement with the theoretical values.

621.317.725.029.45/.5 2285

A Millivoltmeter for the Frequency Range from 1000 to 30 × 10^6 c/s.—H. J. Lindenhovius, G. Arbelet & J. C. van der Breggen. (*Philips tech. Rev.*, Jan. 1950, Vol. 11, No. 7, pp. 206–214.) Six inductance-compensated RC amplifying stages between the input stage and a moving-coil meter with series crystal rectifier give an overall amplification of about 1 500 throughout the frequency range. Compensation for mains fluctuation and valve aging is provided. Voltage ranges are 1 mV, 10 mV, and thence by successive factors of $\sqrt{10}$ to 1 kV, the range being selected by adjustment of a capacitive attenuator.

621.317.73 2286

A Direct-Reading Instrument for Measuring Unbalanced Impedances at Decimetric Wavelengths.—W. H. Ward. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 199–205.) The instru-

ment is based on the reactance-variation method, the circuit elements being lengths of concentric line. Direct voltage measurement is eliminated and replaced by the reading of a piston attenuator. By enclosing the oscillator in the moving part of the attenuator, the use of flexible h.f. cable is avoided. The mechanical drive may, if required, be transmitted from a distance. The instrument measures capacitance from −10 pF to +10 pF and resistance from 10 to 10 000 Ω at frequencies up to at least 1 000 Mc/s, with an accuracy within about 1%. Both scales are direct-reading.

621.317.734 : 621.319.4 **2287**

A Direct-Reading Instrument for the Measurement of the Series Resistance of Capacitors.—F. Gutmann. (*J. sci. Instrum.*, June 1950, Vol. 27, No. 6, pp. 169–170.) A thermocouple ammeter measures the r.f. tank current of a 1.6-Mc/s oscillator, whose output is adjusted to produce full-scale deflection. The capacitor under test is then inserted in series with the tank capacitor. The resultant decrease of tank current is a measure of the series resistance of the tested capacitor. Capacitors from 0.01 μF upwards may be tested.

621.317.755 : 621.385.012 **2288**

Curve Generator for Electron Tubes.—(*Tech. Bull. nat. Bur. Stand.*, May 1950, Vol. 34, No. 5, p. 62.) Equipment developed by M. L. Kuder. I_a/V_a or I_a/V_g families of characteristics are displayed simultaneously on a c.r.o. to an overall accuracy within ±5% on voltage and current readings. Measurement is by a standard co-ordinate rectangle. Marker dots indicate the load-line for the conditions selected. Special circuits are included in the equipment for observation of the step-function signal at the grid of the valve under test and for identifying the curves obtained with positive grid bias.

621.317.772 **2289**

Direct-Reading Phasemeter.—L. H. O'Neill & J. L. West. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 271–273.) The amplitude of the sum or difference of two sinusoidal voltages of equal amplitude depends on the phase difference between them; this is the basis of the simple phase meter here described. The method of adjusting the individual amplitudes and mixing the two voltages, and of determining the sign of the phase difference, are discussed. The overall accuracy is within ±1° over the frequency range 7 c/s to 100 kc/s.

621.317.79.001.4 : 621.397.6 **2290**

Television Monitors.—J. E. B. Jacob. (*Wireless World*, June 1950, Vol. 56, No. 6, pp. 206–210.) Equipment of higher quality than that of the average home set is required. The special features that are necessary in the design of the magnetic lens, focus-correction system, synchronizing-signal separator and black-level control circuit are described.

621.385.18.001.4 **2291**

Measurement of Tube Voltage Drop in Hot-Cathode Gas Tubes.—E. K. Smith. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, pp. 419–422.) 1950 A.I.E.E. Winter General Meeting paper. Increase of the voltage drop is one of the commonest preliminary indications of failure in gas-filled valves. Various methods are described for observing this drop while the valves are in use, typical results are charted, and their significance discussed.

621.396.615 : 621.317.7.001.4 **2292**

VOR Signal Generator.—J. H. Battison. (*Tele-Tech*, May 1950, Vol. 9, No. 5, pp. 37–39, 57.) Operation of the VOR is based on the phase difference between two 30-c/s signals, one with a rotating aerial pattern and the other an omnidirectional reference. The apparatus described generates such signals at a strength sufficient for testing the receiving equipment of aircraft in a nearby field or hangar. The generator can also be used to test runway localizers in which the reference signal is in phase with the variable signal on one side of the runway and 180° out of phase on the other.

621.396.615.029.42 **2293**

A Low-Frequency Sinusoidal-Voltage Source.—L. A. Rosenthal. (*Rev. sci. Instrum.*, April 1950, Vol. 21, No. 4, pp. 302–303.) Frequencies extending from 20 c/s nearly to zero can be obtained by a method in which a variable-frequency audio oscillator is heterodyned with a stable frequency derived from a.c. mains. A mathematical explanation of the mixing operation is given. Application to the testing of a voltage regulator is mentioned.

621.396.615.14.029.63 **2294**

U.H.F. Sweep-Frequency Oscillator.—J. E. Ebert & H. A. Finke. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 79–81.) A variable capacitor, with vane rotated at the high-impedance end of a cavity resonator by a synchronous motor, provides a maximum sweep of 30 Mc/s on the fundamental frequency of an enclosed coaxial-line type of oscillator covering a range of 470–800 Mc/s. The sweep can be varied by altering the capacitor plate spacing. The output voltage is continuously variable from 2 V across 50 Ω to a value 90 db below this. Details of the equipment are given, together with performance curves and a dimensioned sketch of the oscillator.

621.396.822 : 621.316.8 **2295**

Resistor Noise.—(*Radio tech. Dig., Édn franç.*, April 1950, Vol. 4, No. 2, pp. 91–107.) French version of 1465 of June (Paolini & Canegallo).

621.397.645 : 621.316.761.2 **2296**

How to Adjust Frequency Response in Video Amplifiers for TV.—J. H. Roe. (*Broadcast News*, March/April 1950, No. 58, pp. 54–65.) Methods of adjusting video amplifier circuits to obtain satisfactory frequency response characteristics, and methods of measuring their performance, are described with practical details of the necessary equipment. Typical results are illustrated by numerous oscillograms showing the effects of correct alignment and of misadjustment of a particular circuit commonly used for h.f. and l.f. compensation.

621.317 **2297**

Electrical Measurements in Theory and Application. [Book Review]—A. W. Smith. Publishers: McGraw-Hill, London, 1948, 371 pp., 25s. 6d. (*Beama J.*, May 1950, Vol. 57, No. 155, pp. 150–151.) Though mainly addressed to students, the book is recommended to laboratory and test-room workers in general. New methods of measuring capacitance and inductance are included in this edition.

621.317.755 **2298**

Cathode-Ray-Tube Traces. [Book Review]—H. Moss. Publishers: Electronic Engineering, London, 66 pp., 10s. 6d. (*J. sci. Instrum.*, June 1950, Vol. 27, No. 6, p. 175.) "In putting the main emphasis on the geometrical theory of cathode-ray-tube patterns, Dr. Moss has produced a monograph which will be valuable both to the advanced student and to the qualified engineer."

621.396.001.4 **2299**

Radio Servicing Equipment. [Book Review]—E. J. G. Lewis. Publishers: Chapman & Hall, London, 371 pp., 25s. (*J. sci. Instrum.*, June 1950, Vol. 27, No. 6, p. 175.) "Describes in plain and simple language the construction and operation of most of the types of test and measuring equipment used by the radio service engineer."

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

529.781 **2300**

Carrier Frequency for Remote Timing Control.—J. L. Wagner & W. Webb. (*Elect. Mfg, N.Y.*, April 1949, Vol. 43, No. 4, pp. 104–107, 198.) The requirements for a timing-control system operating on power distribution lines are enumerated. A detailed description is given of commercial equipment in which the master clock operates keying relays in the transmitter, providing three separate channel frequencies in the range 2–6 kc/s, one for time correction of slave clocks and the others for applying pulses at 1-minute intervals to attendance recorders, for ringing bells, etc.

534.321.9 : 615 **2301**

Ultrasonics in Therapy.—P. Hémardinquer. (*Rev. belge Électronique*, Feb. 1950, Vol. 1, No. 10, pp. 14–21.) A review of the technique, and description of typical generating apparatus.

535.322.1 : 539.165 **2302**

On an Improvement in Lens-Type β-Ray Spectrographs.—P. Grivet. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1652–1654.)

539.16.08 **2303**
621.387†

Radiation Counters.—Please note that, in this and subsequent issues, the U.D.C. number used will be 621.387† and subdivisions, instead of 539.16.08 used hitherto.

621.317.083.7 **2304**

Present-Day Telemetry Technique.—G. Swoboda. (*Elektrotech. u. Maschinenb.*, May 1950, Vol. 67, No. 5, pp. 129–136.) Review of current methods and description of a pulse system and of one using rotary selector switches.

621.317.087.9 : 621.317.083.7 **2305**

The Metrotype System of Digital Recording and Telemetering.—G. E. Foster. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, pp. 427–430.) 1950 A.I.E.E. Winter General Meeting paper. The system enables electrical quantities to be automatically measured and recorded in numerals, at predetermined intervals. Readings may be transmitted to any distance, a single channel of telegraph quality being adequate. The processes of measuring, transmitting and printing the readings are described.

621.317.39 **2306**

Electrical Methods of Measuring Mechanical Quantities.—(*Engineering, Lond.*, 28th April 1950, Vol. 169, No. 4396, pp. 483–484.) Report of a paper given at the I.E.E. by F. J. Woodcock.

621.365.55† : 674.23 **2307**

High-Frequency Generators : Application in the Wood Industry.—M. Diopère. (*Rev. belge Électronique*, Feb. 1950, Vol. 1, No. 10, pp. 22–28.) Description of different manufacturing processes, e.g., bending, sticking, etc. in which h.f. heating is applied to materials under pressure.

621.38.001.8 : 543/545 **2308**

Electronic Instrumentation for Chemical Laboratories. F. Gutmann. (*J. Brit. Instn Radio Engrs*, May 1950, Vol. 10, No. 5 pp. 194–212.) Reprint. See 710 of March.

621.384.611.2† **2309**

The Proton Synchrotron.—E. J. Lofgren. (*Science*, 24th March 1950, Vol. 111, No. 2882, pp. 295–300.) Brief survey of development of particle accelerators and description of the proton synchrotron now under construction at Berkeley, which will ultimately be capable of producing protons of about 6×10^8 MeV.

621.384.612.1† **2310**

Omegatron — a Miniature Cyclotron.—(*Electronics*, June 1950, Vol. 23, No. 6, pp. 122, 124.) The omegatron operates on the same fundamental principle as the cyclotron and can be used as a mass analyser. In addition to the constant uniform magnetic field a r.f. electric field is applied at right angles. When the r.f. equals the cyclotron frequency the ions spiral outwards and can be collected. Measurement of the frequency corresponding to maximum ion current and a measurement of the magnetic field enable the mass of the particles to be determined.

621.385 : 621.318.572 **2311**

An Electron-Beam Decimal-Counter Tube.—Hollway. (*See 2374.*)

621.385.833 **2312**

Magnetic Cylindrical Lenses with Image-Distortion Correction.—H. Hintenberger. (*Z. Naturf.*, Feb. 1948, Vol. 3a, No. 2, pp. 125–127.) The conditions for exact focusing are determined and also for first- and second-order approximations.

621.385.833 **2313**

The Calculation of Magnetic-Lens Fields by Relaxation Methods.—M. B. Hesse. (*Proc. phys. Soc.*, 1st June 1950, Vol. 63, No. 366B, pp. 386–401.) "The field and lens constants are calculated for two typical magnetic lenses as used in electron microscopes, using the relaxation method developed by Southwell for the solution of potential problems."

621.385.833 **2314**

The Independent Electrostatic Lens under 'Transgaussian' Conditions.—E. Regenstreif. (*C. R. Acad. Sci., Paris*, 8th May 1950, Vol. 230, No. 19, pp. 1650–1652.) A study of the paths of rays, termed transgaussian, which are initially parallel to the axis, but for which r_a/z_a is not negligible.

621.385.833 : 621.396.615.141.2 **2315**

Electron-Optical Mapping of the Space-Charge Field in a Magnetron.—(*Tech. Bull. nat. Bur. Stand.*, May 1950, Vol. 34, No. 5, pp. 57–59.) Method devised by D. L. Reverdin. Space-charge distribution is related to the distorting effect of the electric field in an elementary steady-state magnetron on the shadow pattern formed by two wire screens in the path of a focused nondisturbing axial electron beam. The method may be extended to oscillating magnetrons and to the indication of noise. Results differ widely from predictions based on theory.

621.395.625.3.001.8 **2316**

Various Applications of Magnetic Recording.—P. Hémardinquer. (*Radio franç.*, June 1950, No. 6, pp. 8–16.) Description of the principles and basic circuits of magnetic recorders for secret transmission, phototelegraphy, time measurement, etc.

629.13.014.57 **2317**

The Electronic Automatic Pilot.—M. Nerinckx. (*Rev. belge Électronique*, March/April 1950, Vol. 1, Nos. 11/12, pp. 5–13.) Description of the Sperry automatic pilot Type A-12.

621.38.001.8 **2318**

Industrial Electronics. [Book Review]—A. W. Kramer. Publishers: Pitman Publishing Co., New York, 1949, 311 pp., $6.00. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 136, 140.) ". . . intended for readers who have a good knowledge of general physics and engineering but who have had very little training or experience in electronics."

621.387† **2319**

Counting Tubes. [Book Review]—S. C. Curran & J. D. Craggs. Publishers: Butterworths Scientific Publications, London, 238 pp., 35s. (*J. sci. Instrum.*, June 1950, Vol. 27, No. 6, p. 175.)

PROPAGATION OF WAVES

538.56 : 535.42 2320

On the Diffraction of an Electromagnetic Wave through a Plane Screen.—J. W. Miles. (*J. appl. Phys.*, May 1950, Vol. 21, No. 5, p. 468.) Corrections to paper abstracted in 202 of January.

621.396.11 2321

The First Ionospheric-Storm-Warning Service 1941-45.—J. S. Kojan & G. A. Isted. (*Marconi Rev.*, 1950, Vol. 13, No. 97, pp. 53–71.) The development of this service at Baddow is traced from its origin during the war, and an account is given of the factors upon which the forecasts are based. The efficiency of the storm warnings is reviewed and new developments are discussed in connection with future storm-warning services; an 'idealized' warning system might include solar-corona observations, solar-noise observations, monitoring of radio circuits having great-circle paths in (or near) the auroral zones, geomagnetic measurements, sunspot observations.

621.396.11 : 551.510.535 2322

The Air Force Interest in Sporadic E Ionization.—Gerson. (*See* 2212.)

621.396.81 2323

Reception [at Madrid] **of** [s.w.] **Transmissions from Great Britain, the Vatican and U.S.A.**—R. G. Sacasa. (*Rev. Telecomunicación, Madrid*, Dec. 1948, Vol. 4, No. 14, pp. 10–16.) Graphs show receiver output power variations during March 1948 at various times of the day for transmissions in the range from 16.85 m to 50.26 m. Average values are compared with those for signals from Spanish and Australian stations.

621.396.81 2324

Washington and Madrid [radio] **Propagation Forecasts.**—R. G. Sacasa. (*Rev. Telecomunicación, Madrid*, June 1949, Vol. 4, No. 16, pp. 20–29.) A comparison is made between N.B.S. forecast charts and the author's, based on experimental observations, for reception of wavelengths in the range 13–31 m. Agreement for January and February 1949 was better than for 1942, but there were still appreciable discrepancies.

621.396.81 2325

Back-Scatter Observations by the Central Radio Propagation Laboratory — August 1947 to March 1948.—W. L. Hartsfield, S. M. Ostrow & R. Silberstein. (*Bur. Stand. J. Res.*, Feb. 1950, Vol. 44, No. 2, pp. 199–214.) A high-power pulsed transmitter, the circuit diagram of which is given, and westwardly beamed aerial system were used, transmissions being made from Sterling, Virginia, at a frequency of 13.66 Mc/s. Back-scatter observations are presented graphically and photographs are shown of different types of echo pattern received. Back-scatter from both the ground and the E-region was identified, ground scatter usually predominating. Comparisons of results are made with transponder signals and skip-distance maps drawn from concurrent ionospheric data. Curves of calculated transmission and echo delays are also given.

621.396.81 2326

Effect of a Sudden Ionospheric Disturbance on Long Radio Waves Reflected Obliquely from the Ionosphere.—K. Weekes. (*Nature, Lond.*, 10th June 1950, Vol. 165, No. 4206, pp. 935–936.) The behaviour of radio waves reflected at oblique or at steep incidence during periods of sudden ionospheric disturbance is outlined. Signal-strength measurements on the Danish transmissions for the Decca navigation system suggest that for frequencies of about 100 kc/s, transmitted over about 900 km, the reflected wave amplitude is increased during a sudden ionospheric disturbance, corresponding to an effective reflection coefficient of 0.25, which is about five times the normal value. When waves of the same frequency are reflected at steep incidence, a decrease in amplitude is observed. In either case, the associated phase change corresponds to a decrease in the height of reflection.

On frequencies above 2 Mc/s a decrease in amplitude occurs both for vertical and oblique incidence, whereas frequencies in the region of 16 kc/s show little amplitude change at steep incidence but an increase at oblique incidence. The above results confirm and extend the recent observations of Smith-Rose (1228 of May).

621.396.812 2327

A Survey of Ionospheric Cross-Modulation.—L. G. H. Huxley & J. A. Ratcliffe. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, p. 165.) Discussion on 211 of January.

621.396.812 2328

Contribution to the Study of Gyromagnetic Frequency by means of Gyro-Interaction of Radio Waves in the Ionosphere.—M. Cutolo. (*Nuovo Cim.*, 1st Oct. 1948, Vol. 5, No. 5, pp. 475–488.) A full account of experiments carried out in 1947 and briefly reported in 2055 of 1948. The results confirm the previous observation that there is a regular rise in the value of the resonance frequency during the course of the night.

621.396.812 2329

Low-Level Atmospheric Ducts.—R. F. Jones. (*Nature, Lond.*, 17th June 1950, Vol. 165, No. 4207, p. 971.) The variations in signal strength over paths in the Cardigan Bay area in conditions of strong wind can be related to the origin and subsequent track of the air over that area at the time. In particular, the drying effect on the lowest layers due to recent travel over land is important. See also 2033 of 1949.

551.510.535 : 621.396.11 2330

Short-Wave Radio and the Ionosphere. [Book Review]—Bennington. (*See* 2218.)

RECEPTION

621.396.621 2331

The Transmission-Line Discriminator.—P. Magne. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 89–93.) The principle is described by which discrimination is effected with an open-ended and a closed coaxial line across a common f.m. source. Calculation is made of the length of line required and of the amount of third harmonic. A harmonic-filter circuit including two valves Type 6AK5 is described for a discriminator for use in a 20-Mc/s band centred at 105 Mc/s. The response curve is flat over the whole band and distortion is of the order of 0.1%.

621.396.621.5 2332

A Crystal Tetrode used as a Frequency Changer.—R. W. Haegele. (*Onde élect.*, May 1950, Vol. 30, No. 278, pp. 239–241.) Preliminary experimental study showing the conversion characteristics as functions of the collector current, local oscillator voltage, etc. The crystals were of the type normally used in Ge diodes Type IN34, the points of contact of the three electrodes at the crystal surface forming an equilateral triangle of side about 0.05 mm. Signal frequencies up to at least 200 Mc/s may be used; there is little interaction between the input circuits; conversion gain is high. The maximum i.f. appears to be sensibly equal to the maximum frequency of amplifying crystal triodes, so that the input signals may have much higher frequencies.

621.396.821 : 621.317.7.087 : 551.594.6 2333

On the Recording of the Mean Level of Atmospherics.—Carbenay. (*See* 2282.)

621.396.822 2334

Thermal Noise at High Frequencies.—A. van der Ziel. (*J. appl. Phys.*, May 1950, Vol. 21, No. 5, pp. 399–401.) "Spenke's discussion of thermal noise from the point of view of the electron theory leads to a result which differs from Nyquist's original formula at frequencies ν such that $h\nu/kT \geqslant 1$. This discrepancy is due to the assumptions which Spenke made in his analysis."

621.396.822 : 621.396.619.13 2335

The Spectrum of Frequency-Modulated Waves after Reception in Random Noise: Parts 1 & 2.—D. Middleton. (*Quart. appl. Math.*, July 1949, Vol. 7, No. 2, pp. 129–174, and April 1950, Vol. 8, No. 1, pp. 59–80.) Mathematical analysis. The wave emerging from the i.f. amplifier and entering the limiter is assumed to be of the narrow-band type, the limiter providing an output voltage proportional to the instantaneous amplitude of the wave for amplitudes less than a certain threshold value, and a constant output for larger amplitudes. The discriminator is 'ideal' and provides an output voltage directly proportional to the instantaneous difference in frequency between the input wave and the central i.f.

The spectrum of the signal and of the noise emerging from the discriminator is analysed generally. The results of the analysis for no limiting and extreme limiting, for different input signal/noise ratios and for carrier mistuning, are presented graphically. Part 2 extends the theory given above to the general case of an arbitrary degree of limiting, the postulated conditions being the same as before. The spread of the spectrum of the noise due to the clipping produced by the limiter is evaluated. The results for various degrees of limiting are presented for the two special cases of no carrier (noise alone) and strong carrier.

621.396.621 + 621.396.61 2336

Radio Receivers and Transmitters. [Book Review]—S. W. Amos & F. W. Kellaway. Publishers: Chapman & Hall, London, 2nd edn revised 1948, 356 pp., 25s. (*Beama J.*, April 1950, Vol. 57, No. 154, pp. 117–118.) Deals mainly with receivers, only one of the ten chapters being devoted to transmitters. "... this book contains much useful information, and where proofs are lacking references are indicated."

621.396.621 + 621.396.645] : 621.385 2337

Electronic Valves: Books II-IV. [Book Review]—(*See* 2388.)

STATIONS AND COMMUNICATION SYSTEMS

621.39.001.11 2338

On the Maximum Transmission Capacity of a Channel in the Presence of Noise.—J. Laplume. (*Onde élect.*, May 1950, Vol. 30, No. 278, pp. 235–238.) Paper presented at the Congrès d'Électronique et de Radioélectricité, January 1950. Random noise is the only essential factor limiting the capacity of a channel. A formula is derived showing the number of signals which may be transmitted in a given time interval. In the ideal case this number is an exponential function of the bandwidth. In the case of a.m. or f.m. the number is proportional to the pass band. With p.c.m. the theoretical limit may be reached. Quantization of a continuous message is possible only if the channel bandwidth is greater than that necessary for s.s.b. a.m. transmission, the bandwidth being increased at the expense of transmission power. See also 1649 of 1949 (Shannon) and 2319 of 1949 (Tuller).

621.39.001.11 : 519.283 2339

Correlation Functions and Communication Applications.—Lee & Wiesner. (*See* 2262.)

621.394/.396 2340

Telecommunications and Heaviside.—(*Electrician*, 26th May 1950, Vol. 144, No. 3754, p. 1752.) Report of a paper 'Fifty Years' Development in Telephone and Telegraph Transmission in Relation to the Work of Heaviside', by W. G. Radley, given at one of the I.E.E. Heaviside Centenary Commemorative Meetings, May 1950. Heaviside in 1876 first realized the need for an inductance term and, subsequently, for a leakage-conductance term in the basic equations for line transmission: the use of loading coils as standard practice followed from his theory. Modern improvements of these coils are mentioned. Heaviside's work on e.m. waves in space is considered and an account is given of systems developed to overcome the effects of ionospheric irregularities on long-distance radio communication.

621.395 2341

The Telephone and the Laboratory: Part 1.—H. M. Trainor. (*Trans. S. Afr. Inst. elect. Engrs*, Nov. 1949, Vol. 40, Part 11, pp. 251–274. Discussion, pp. 275–280.) The organization of telecommunications research in the Bell System, U.S.A., the British Post Office and the Australian Post Office is reviewed, and an account is given of work done in South Africa. This has consisted largely in the quality testing of equipment and the investigation of problems arising from the special conditions of use existing in South Africa. Laboratory facilities of the Post Office and other services are described and various laboratory and field investigations are discussed. Part 2: 2342 below.

621.395 2342

The Telephone and the Laboratory: Part 2.—H. M. Trainor. (*Trans. S. Afr. Inst. elect. Engrs*, March 1950, Vol. 41, Part 3, pp. 57–79. Discussion, pp. 80–86.) Relevant theories of speech, hearing and noise are reviewed and a detailed discussion is given of the transmission aspects of the telephone instrument, which is a source of distortion in a telephone system. The development of the modern instrument has been based on a detailed knowledge of speech characteristics and the various noise components affecting reproduction. The carbon type transmitter and the importance of improved magnetic materials in reduction of frequency distortion in receivers are discussed. Side tone can be reduced by modification of the matching induction-coil circuit. Tests of sensitivity, frequency response, nonlinear and amplitude distortion and articulation, are important measures of the efficiency of a system. The overall effective transmission or repetition rating, as determined in practice, is the final criterion of efficiency. Part 1: 2341 above.

621.396.1 2343

Technical Repercussions of the Copenhagen Plan.—J. Garcin. (*Toute la Radio*, May 1950, Vol. 17, No. 145, pp. 152–154.) Comment on the practical effects of the redistribution of wavelengths for French broadcasting, and suggested receiver adjustments to minimize interference.

621.396.619.16 2344

Pulse-Time and Pulse-Width Modulation.—P. Bréant. (*Ann. Télécommun.*, Oct. 1948, Vol. 3, No. 10, pp. 309–316.) Theoretical study made in 1946. The systems are defined and a rapid method for determining the modulation spectrum is described. In the case of p.t.m., demodulation cannot be effected with a simple low-pass filter. In p.w.m. this demodulation method is effective only if (*a*) modulation depth is small; (*b*) the sides of the pulses displaced by the modulation are steep; (*c*) only one side of the pulse is displaced. Demodulation by simple filtering is thus of little practical use for p.m. signals.

621.396.619.16 2345

Narrow-Band Pulse Communication.—T. Roddam. (*Wireless World*, June 1950, Vol. 56, No. 6, pp. 202–205.) Short square-wave amplitude-modulated pulses are converted to Gaussian pulses: the most efficient method is to use an amplifier with several 'maximal flatness' stages [3013 of 1941 (Landon)] and one plain RC stage. After the Gaussian pulses have travelled along telephone cables provided with suitable intermediate repeaters, the shape is preserved but there is overlapping of the pulse signals. The overlapping increases as the bandwith is decreased, causing cross-modulation, but a corrector circuit can be used to eliminate this effect.

621.396.65 2346

Carrier Power Requirements for Long-Distance Communication by Microwaves.—A. G. Clavier. (*Elect. Commun.*, March 1950, Vol. 27, No. 1, pp. 39–47.) A general expression is given for the path attenuation of a radio link in terms of wavelength, distance, and effective areas of transmitting and receiving aerials; abacs are presented for finding values of the free-space attenuation between (*a*) nondirectional and (*b*) parabolic aerials. Conditions for p.c.m. and f.m. transmission are compared; the r.f. power required for a p.c.m. system is 17 db less than for a corresponding f.m. system, suitable allowances being made for fading and for receiver noise, but under conditions of deep fading the f.m. system is the better.

621.396.65 2347

A Simple Microwave Relay Communication System.—M. G. Staton. (*Tele-Tech*, April 1950, Vol. 9, No. 4, pp. 40–42, 44.) This equipment operates in the 952–960-Mc/s band and uses conventional valves and circuits. The carrier frequency is derived by repeated multiplication from a ph.m. crystal-controlled oscillator operating at about 1 Mc/s, and the transmitter output is < 3 W. The receiver is a superheterodyne with self-contained power supply. Dipole aerials with 42-in. parabolic reflectors are used for both transmitter and receiver. Unattended repeater stations are provided with automatic monitoring arrangements.

621.396.65 2348

V.H.F. Links at Manila Airport.—E. J. Rudisuhle & P. B. Patton. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 82–85.) Line-of-sight f.m. links in the 160-Mc/s band provide over 150 speech, telegraphy, printer and control circuits between the control station and remote transmitting and receiving stations. Details are given of some of the special circuits used.

621.396.823 : 621.395.44 2349

On Radiation from Overhead Transmission Lines.—M. Jenssen. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 166–178.) An analysis is made of the fields of single and multiple lines over imperfectly conducting earth. Field strengths measured along profiles transverse to a 3-phase line in a valley agreed quite well with theoretical values, for different connections of the lines. Single phase-to-earth connection in power-line carrier systems is undesirable if interference is to be minimized. It is suggested that horizontal aerials may be useful for low-power broadcasting transmission in valleys.

621.396.931 2350

The Introduction in Switzerland of the Public Telephone Service to Vehicles.—H. Kappeler. (*Bull. schweiz. elektrotech. Ver.*, 9th July 1949, Vol. 40, No. 14, pp. 433–439. In French, with German summary.) By the service introduced at Zürich in June 1949 2-way telephone connection via a radio link may be made with any suitably equipped vehicle plying within about 10 km of a fixed transmitting/receiving station. Details are given of the automatic calling and selection system and of the R/T equipment. Phase modulation is used, with carrier frequencies between 31 and 41 Mc/s.

621.396.932 : 621.396.5.029.62 2351

Thames Radio Service.—(*Wireless World*, June 1950, Vol. 56, No. 6, pp. 215–216.) For an abstract of another account see 999 of April (Neale & Burr).

SUBSIDIARY APPARATUS

621-526 : 621.396.645.37 2352

Feedback Amplifiers and Servo Systems.—Ward. (*See* 2175.)

621-526 : 621.398 2353

Synchro Units for Remote Indication and Control.—S. N. Mead & G. E. Day. (*Elect. Mfg, N.Y.*, April 1949, Vol. 43, No. 4, pp. 74–79, 204.) Operating characteristics are given of many types of a.c. self-synchronous transmitter and indicator units commercially available, together with design details useful in selecting equipment for particular practical applications.

621.3.077.2[.3] : 621.3.016.35 2354

On the Application of Stability Criteria to an Amplidyne Control Circuit.—F. van Geertruyden. (*H.F., Brussels*, 1950, No. 6, pp. 169–176.) The amplidyne, a dynamoelectric amplifier, plays a part in control circuits very similar to that of an electronic amplifier. The mathematical study of such amplifiers, particularly with reference to stability, has been extended to the amplidyne. Two stability criteria are examined: that of Leonhard, which is mathematically tractable, and the generalized Nyquist criterion, which is particularly suitable for use in the experimental study of a control circuit. The formulation of the equation for a control circuit is simple in operational notation. Transients superposed on the steady state are specially studied. An account is given of a complete numerical investigation, both theoretical and experimental, of the stability in two types of alternator-voltage regulation. In one case the amplidyne supplies the alternator excitation directly and in the other case feeds a separate exciter.

621.316.726 : 621.314.3† 2355

A Magnetic-Amplifier Frequency Control.—L. J. Johnson & H. G. Schafer. (*Elect. Engng, N.Y.*, May 1950, Vol. 69, No. 5, p. 445.) Summary of 1950 A.I.E.E. Winter General Meeting paper. A circuit is described for stabilizing the 60-c/s output frequency of a small motor-driven alternator. A magnetic amplifier is controlled by the output of a pair of balanced tuned circuits fed from a pilot generator attached to the dynamotor shaft, and its output in turn regulates the field of the dynamotor. Temperature stability is obtained by the use of permalloy cores in the tuned circuits. Frequency regulation of the order of 1 part in 5 000 at normal temperatures is claimed.

621.396.682 2356

Design, Construction and Test of a Stabilized Anode-Voltage [supply unit].—L. Chrétien. (*T.S.F. pour Tous*, May 1950, Vol. 26, No. 259, pp. 177–180.) Details and performance of equipment using the circuit noted in 1532 of June.

621.398 2357

Radio Synchro-Motor [selsyn].—In 1258 of May please change J. R. Duthil to J. R. Dutilh.

TELEVISION AND PHOTOTELEGRAPHY

621.397.6 2358

Line-by-Line Black-Level Control of Television Signals.—N. N. Parker Smith. (*Marconi Rev.*, 1950, Vol. 13, No. 97, pp. 81–85.) The gain of a receiver or the carrier level of a transmitter is controlled by a voltage

derived during part of the 5-μs black-level period at the commencement of each line. This control voltage, proportional in amplitude to the black-level signal, remains steady over the line period of approximately 100 μs, and yet follows any changes which occur between successive lines. The description of the control arrangement is illustrated by circuit and waveform diagrams.

621.397.6 2359

Simplified Television for Industry.—R. C. Webb & J. M. Morgan. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 70–73.) Equipment using the vidicon camera tube (2040 of August).

621.397.6 : 621.317.79.001.4 2360

Television Monitors.—Jacob. (*See* 2290.)

621.397.611.21.002.2 2361

Producing the 5820 Image Orthicon.—R. B. Janes, R. E. Johnson & R. R. Handel. (*Electronics*, June 1950, Vol. 23, No. 6, pp. 93–95.) Short illustrated account of the special techniques used.

621.397.62 2362

Magnetic Deflector Coils.—(*Radio tech. Dig., Édn franç.*, June 1950, Vol. 4, No. 3, pp. 131–156.) An article based primarily on 2043 of August (Cocking), with added bibliography.

621.397.621.2 2363

R.C.A. Color Kinescope Demonstrated.—(*Tele-Tech*, May 1950, Vol. 9, No. 5, pp. 20–21, 63.) In the two laboratory-produced tubes described the screen is composed of 351 000 colour-emitting dots arranged in triangular groups of three, corresponding to the three primary colours of the picture. An apertured mask is interposed between the electron beam source and the screen so that one colour only is emitted by each group as it is scanned. (*a*) Three-gun tube. Each gun is operated in the time sequence corresponding to the sampling process at the transmitter. Each gun excites one colour only on the tube face. (*b*) Single-gun tube. Two sets of coils fed with quadrature currents at the sampling frequency generate a rotating field producing circular deflection of the beam. The phase of the field determines which colour is excited on the tube face.

621.397.645 : 621.316.761.2 2364

How to Adjust Frequency Response in Video Amplifiers for TV.—Roe. (*See* 2296.)

621.397.743 : 621.392.5 : 621.315.212 2365

Equalization of Coaxial Lines.—Gould. (*See* 2152.)

621.397.82 : 621.392.52 2366

The Latest Techniques for the Elimination of Ham TVI.—Rand. (*See* 2156.)

621.397.5 2367

Television Explained. [Book Review]—W. E. Miller. Publishers: The Trader Publishing Co., London, 3rd edn, 104 pp., 5s. (*J. Brit. Instn Radio Engrs*, May 1950, Vol. 10, No. 5, p. vi.) A number of sections have been revised and additional information is included. "The treatment is non-mathematical . . . The student, the radio service engineer and the amateur will find this book an excellent investment. . . ."

TRANSMISSION

621.394.61 2368

Low-Frequency Radiotelegraph Transmitter for Arctic Use.—H. P. Miller, Jr. (*Elect. Commun.*, March 1950, Vol. 27, No. 1, pp. 11–20.) A conventional 10-kW equipment for operation in the frequency range 80–200 kc/s or, in later models, 200–300 kc/s. Single-frequency operation with on-off keying is normally used, but provision is also made for modulated c.w. operation. Arctic conditions necessitate air cooling of the F.892R final amplifier valve and preheating of the Hg-vapour rectifiers. Unit construction is employed to facilitate the transportation of the equipment by air.

621.396.61 : 621.396.97 2369

Contribution to the Study of High-Efficiency Broadcasting Transmitters.—J. Polonsky. (*Ann. Radioélect.*, April 1950, Vol. 5, No. 20, pp. 109–124.) The simplified theory of the grid-modulated amplifier is criticized and a more rigorous theory put forward. The disadvantages of the Doherty-Terman circuit (4020 of 1936 and 4300 of 1938) are practically eliminated in the experimental S.I.F. transmitter at Boutigny by (*a*) locating the impedance inverter at the r.f. exciter input; (*b*) mounting the two modulator valves in a cathodyne connection; (*c*) incorporating an overall degenerative and a local regenerative feedback loop. Useful carrier power of this transmitter is 18 kW, anode efficiency of the final stage 73%, overall efficiency 43%. Other characteristics are shown. The advantages of such equipment compared with those using anode modulation of the last h.f. stage are stressed.

621.396.615.142.2 : 621.396.619.13 2370

Experiments on the Modulation of a Reflex Klystron.—J. van Mulders. (*HF, Brussels*, 1950, No. 6, pp. 153–163.) Theory of the relation between the oscillation frequency of a reflex klystron and the reflector voltage is reviewed and measurements of the modulation index of an American klystron, Type 707B, are described. The modulation index was determined from photographs of the modulation spectrum displayed on a c.r.o. The modulation distortion can at once be found from the modulation index when the static characteristic of the klystron (frequency as a function of reflector voltage) is known.

621.396.619.23 2371

Rectifier Modulators with Frequency-Selective Terminations.—D. G. Tucker. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 205–207.) Discussion on 260 of January.

621.396.619.23 2372

Non-Linear Distortion in a Cowan Modulator.—V. Belevitch. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 164–165.) Author's reply to 1552 of June (Tucker & Jeynes).

621.396.61 + 621.396.621 2373

Radio Receivers and Transmitters. [Book Review]—Amos & Kellaway. (*See* 2336.)

VALVES AND THERMIONICS

621.385 : 621.318.572 2374

An Electron-Beam Decimal-Counter Tube.—D. L. Hollway. (*Nature, Lond.*, 27th May 1950, Vol. 165, No. 4204, pp. 856–857.) The tube described is 2.9 cm in diameter and 15 cm long, and operates at the relatively low anode voltage of 500 V with a beam current of 300 μA and a frequency range 0–68 kc/s. The beam is caused to move in a path comprising alternate radial and circumferential steps by means of a special 5-plate deflector system with appropriate connections to a 5-segment slotted collector electrode. Visual indication of the count is given by projection on to the fluorescent screen of numbers cut in the back segments of the collector electrode.

621.385.029.63.64 2375

Wave Propagation in a Slipping Stream of Electrons: Small Amplitude Theory.—G. G. Macfarlane & H. G. Hay. (*Proc. phys. Soc.*, 1st June 1950, Vol. 63, No. 366B, pp. 409–427.) Amplifying waves are found to travel along a slipping stream of electrons for all frequencies, a slipping stream being defined as one in which the

electrons move in parallel paths with velocities varying with distance transverse to their motion. A slipping-stream valve may have the properties of a two-beam valve or a travelling-wave valve. The characteristics of one or the other are displayed according to whether $(V_a - V_{-a})/(V_a + V_{-a}) \leq 0.42$, the velocity of the electrons varying linearly from V_{-a} to V_a across the stream. A slipping stream inside a waveguide, capable of guiding a TM wave of slow phase-velocity in the absence of the electrons, acts very much as a travelling-wave valve with a uniform electron beam.

621.385.029.63/.64 **2376**

Experimental Investigation of a Long Electron Beam in an Axial Magnetic Field.—J. S. A. Tommet. (*Chalmers tekn. Högsk. Handl.*, 1950, No. 92, 16 pp. In English.) An extension of an experimental investigation (561 of 1949) of the effect of the focusing magnetic field on the amplification of a travelling-wave valve. The form of the magnetic field produced by two helical focusing coils is studied and the collector current measured as a function of the number of turns of the coils. To avoid helix current due to space-charge effect for a helix of length 35 cm and diameter 3 mm, using a beam current of 1.5 mA and an accelerating voltage of 2 200 V, a field of 400 gauss or more is necessary.

621.385.029.63/.64 **2377**

Traveling-Wave Tubes: Part 2.—J. R. Pierce. (*Bell Syst. tech. J.*, April 1950, Vol. 29, No. 2, pp. 189–250.) The second instalment (Chapters 4, 5 and 6) of a forthcoming book. Chapter 4 discusses the two methods of analysing iterated waveguide structures used in travelling-wave valves, involving field theory and lumped-circuit analogues respectively. These methods are illustrated by analysis of typical simple structures. Chapter 5 is a discussion of group and phase velocities, gain and bandwidth, and the criteria by which the quality of a circuit should be judged. The helix and various resonator circuits are compared. In Chapter 6 the circuits are described in terms of normal modes of e.m. wave propagation. Part 1: 1810 of July.

621.385.029.63/.64 **2378**

1 000-Watt Traveling-Wave Tube.—S. E. Webber. (*Electronics*, June 1950, Vol. 23, No. 6, p. 100–103.) An article based on a 1949 National Electronics Conference paper. An illustrated description and construction details are given of a water-cooled valve which as a power amplifier produces a power gain of about 25 at 450 Mc/s. The efficiency is 20% when operated with a beam voltage of 5 000 V and beam current of 1 A. Unwanted oscillations are suppressed by an attenuator consisting of a conducting coating on the outside of the valve. The inherent bandwidth is more than adequate for most commercial applications where a wide transmission band is required. See also *Proc. nat. Electronics Conference, Chicago*, 1949, Vol. 5, pp. 493–499.

621.385.032.213.2 **2379**

Change of Mutual Conductance with Frequency.—W. Raudorf. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 164.) Author's reply to 1812 of July (Eisenstein). See also 1301 of May.

621.385.032.216 **2380**

Contribution to the Study of Oxide Cathodes.—F. Violet & J. Riethmaller. (*Le Vide*, Nov. 1949, Vol. 4, No. 24, pp. 687–720.) Reprint. See 2956 of 1949.

621.385.15 **2381**

Secondary-Emission Valve.—G. Diemer & J. L. H. Jonker. (*Wireless Engr*, May 1950, Vol. 27, No. 320, pp. 137–143. Correction, *ibid.*, June 1950, Vol. 27, No. 321, p. 194.) "An experimental secondary-emission valve is described. The high figure of merit (g_m/C = 3.0 mA/V-pF) that is obtained by adding one stage of secondary emission to an earthed-grid triode of rather conventional construction makes the valve useful as a wideband amplifier for those cases where a very low noise figure is not required; typical figures are: at 1 m wavelength 30 db gain (G) with a bandwidth (B) of 3.5 Mc/s, at 50 cm G = 15 db with B = 20 Mc/s, at 30 cm G = 10 db with B = 10 Mc/s. The maximum power output is for $\lambda > 1$ m about 1.5 watts. At 7 m wavelength the noise figure amounts to 12 db; this rather high value is due to secondary emission. It is shown that for this secondary-emission noise a kind of space-charge smoothing effect exists."

621.385.18.001.4 **2382**

Measurement of Tube Voltage Drop in Hot-Cathode Gas Tubes.—Smith. (*See* 2291.)

621.385.2 **2383**

Space Charge in Planar Diodes.—C. S. Bull. (*Proc. Instn elect. Engrs*, Part III, May 1950, Vol. 97, No. 47, pp. 159–165.) Following Langmuir's assumptions, the author considers five variables: total emissivity i_0, anode current i, anode voltage V, the value V_m of Langmuir's 'potential minimum' and the cathode/anode separation x. Of these only three are independent. From them are formed thirty partial differential coefficients, which are tabulated. By using these, quantities not accessible to direct measurement can be calculated. Particular attention is paid to the 'motional transconductance' $(\delta i/\delta x)_{i_0}$, which is related to scale changes in valves and to their microphonic properties; a method for determining this quantity is described.

621.385.3 : 621.396.615.14 **2384**

Electron Transit Time.—M. R. Gavin. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 164.) Comment on 1820 of July (Chatterjee & Sreekantan).

621.385.832 **2385**

Improved Production Methods for Television C.R. Tubes.—(*Engineer, Lond.*, 21st April 1950, Vol. 189, No. 4917, pp. 482–483.) Description of an automatic machine installed at the Mullard factory for joining the necks and heads of c.r. tubes; the continuous production rate is 60 bulbs per hour.

621.385.832 : 535.371.07 : 621.396.9 **2386**

Visibility on Cathode-Ray Tube Screens: Positive *vs* Negative Signals on an Intensity Modulated Scope.—M. W. Harriman & S. B. Williams. (*J. opt. Soc. Amer.*, Feb. 1950, Vol. 40, No. 2, pp. 102–104.)

621.396.615.141.2 : 621.385.833 **2387**

Electron-Optical Mapping of the Space-Charge Field in a Magnetron.—(*See* 2315.)

621.385 : [621.396.621 + 621.396.645 **2388**

Electronic Valves: Books II-IV. [Book Review]—Cleaver-Hume Press, London and N. V. Philips, Eindhoven, Holland.

Book II. Data and Circuits of Receiver and Amplifier Valves. 409 pp., 21s.

Book III. First supplement to Book II. 213 pp., 12s. 6d.

Book IV. Application of the Electronic Valve in Radio Receivers and Amplifiers. 416 pp., 35s. (*Wireless Engr*, June 1950, Vol. 27, No. 321, pp. 193–194.) Book I was noted in 519 of February. Books II and III chiefly consist of details of the characteristics of Philips' valves, one dealing mainly with the E, C and K series and the other with the more recent E20, U20, D20 and U series and their applications. Book IV is in the nature of a wireless-receiver textbook and is of general application. "The treatment throughout is very thorough but . . . almost entirely from the viewpoint of the designer of broadcast receivers." See also 991 of April.

621.385.83 2389

The Theory and Design of Electron Beams. [Book Review]—J. R. Pierce. Publishers: D. Van Nostrand, New York, 1949. 197 pp., $3.50. (*Wireless Engr*, May 1950, Vol. 27, No. 320, p. 166; *Electronics*, June 1950, Vol. 23, No. 6, pp. 134–136.) "Written on the graduate level, [the book] discusses that material on electron beams which lends itself most readily to mathematical analysis, although some attention is also given to experimental techniques . . . [It] is clearly intended for those concerned with the formation and focusing of electron beams for use in such devices as low-frequency amplifiers, oscillators, and, especially, microwave tubes... Comparisons between theory and practice are frequent. All chapters are followed by excellent problems . . ."

MISCELLANEOUS

6 : 061.4 2390

British Scientific Instruments exhibited at Olympia.—(*Metallurgia, Manchr*, May 1950, Vol. 41, No. 247, pp. 411–413.) Short descriptions of equipment shown on the stand of the Scientific Instrument Manufacturers' Association at the 1950 British Industries Fair, including a wide range of electronic apparatus, magnetic and electrical instruments, electromechanical equipment, temperature measurement and control apparatus, optical equipment and vacuum plant.

621.39 Heaviside 2391

The Heaviside Centenary.—(*Electrician*, 26th May 1950, Vol. 144, No. 3754, pp. 1747–1748.) Report of Heaviside Centenary Commemorative Meetings, May 1950. The opening paper, 'Heaviside, the Man', by G. Lee, was followed by short tributes from leading scientists. Abstracts of papers on particular aspects of Heaviside's work will be found in the relevant sections.

621.39 Heaviside 2392

Oliver Heaviside and his Layer.—E. V. Appleton. (*Wireless World*, May 1950, Vol. 56, No. 5, pp. 187–188.) A short appreciation of Heaviside's work, with special reference to his suggestion concerning the possible existence of a conducting layer in the upper atmosphere. See also 2391 above.

621.3 2393

Leitfaden der Elektrotechnik. Vol. 1: Grundlagen der Elektrotechnik. [Book Review]—Moeller & Wolff. Publishers: B. G. Teubner Verlagsgesellschaft, Leipzig, 4th edn, 358 pp. (*Wireless Engr*, June 1950, Vol. 27, No. 321, p. 193.) This textbook is unreservedly recommended to both students and teachers with a knowledge of German; the foundations of electrical engineering are laid with great thoroughness. A new chapter is included on the calculation of single-phase and three-phase transmission lines.

621.38'.39 2394

Electronic Engineering Master Index for 1947-1948. [Book Review]—Publishers: Electronics Research Publishing Co., New York, 1950, 339 pp., $19.50. (*J. Franklin Inst.*, April 1950, Vol. 249, No. 4, p. 340.) The second supplement of this reference work, which covers all aspects of the subject, and indexes material from about 250 scientific periodicals.

Second Group

ACOUSTICS AND AUDIO FREQUENCIES

016 : 534 2395

References to Contemporary Papers on Acoustics.—A. Taber Jones. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 395–399.) Continuation of 1838 of August.

534.012 : [532.111 + 534.22 2396

The Mean Pressure and Velocity in a Plane Acoustic Wave in a Gas.—P. J. Westervelt. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 319–327.) The one-dimensional equation for a travelling wave is discussed to the second order of approximation, using Airy's solution to the Lagrangean form of the equation as a basis; second-order effects are reviewed and correlated. Forces on a particle in the wave have a time-average component which is opposed to the radiation pressure and whose magnitude may exceed that of the radiation pressure; this may result in a particle drift velocity, in a direction opposed to wave propagation, of about 1 cm/sec for a sound pressure level of 151 db in air. Standing waves of large amplitude are also considered.

534.321.9 : 061.3 2397

International Convention on Ultrasonics.—G. Bradfield. (*Nature, Lond.*, 22nd July 1950, Vol. 166, No. 4212, pp. 143–144.) A short report of the proceedings at the convention held in Rome, June 1950, with an outline of some of the subjects discussed. Slightly more than 50% of all the contributions were concerned with biology and medicine.

534.321.9 : 615 2398

Ultrasonic Apparatus for Therapeutic Applications.—H. Thiede. (*Elektrotechnik, Berlin*, June 1950, Vol. 4, No. 6, pp. 219–223.) Discussion of the physical characteristics of ultrasonic waves and description of piezoelectric and magnetostriction generators for frequencies up to about 3 Mc/s, including some giving focused beams.

534.322.3 : 534.6 : 621.396.822 2399

Background Noise and the Use of White Noise in Acoustics.—P. Chavasse & R. Lehmann. (*Ann. Télécommun.*, June 1950, Vol. 5, No. 6, pp. 229–236.) The theory of background noise is reviewed. A neon tube is preferred to a pentagrid valve as a practical generator of white noise. The circuit of the artificial voice (3404 of 1947) is shown. Architectural, physiological and electro-acoustic applications of noise sources are indicated. Some 50 references are given.

534.415 2400

Stroboscopic Audio-Frequency Spectrometer.—F. A. Fischer. (*Fernmeldetech. Z.*, May 1950, Vol. 3, No. 5, pp. 174–180.) The stroboscopic method of measurement is discussed and two instruments are described. A light source is modulated with the signal to be measured and viewed through a revolving stroboscopic screen characteristically sectioned. Alternatively, a fixed screen suitably sectioned, e.g. with a hyperbolic pattern for a linear frequency scale, is viewed in a revolving mirror. Frequency range is 60 to 6000 c/s.

534.613 2401

On the Radiation Pressure of Spherical Waves.—R. Lucas. (*C. R. Acad. Sci., Paris*, 5th June 1950, Vol. 230, No. 23, pp. 2004–2006.) An expression is derived for the acoustic pressure due to the pulsation of a sphere of dimensions small compared with the wavelength. Near the surface of the sphere the value is twice the density of the kinetic energy; this greatly exceeds the total energy density, and agrees with the value deduced from Brillouin's pressure tensor. Consideration of the pressure exerted by a stationary spherical wave on a reflecting boundary surface leads to an expression involving the factor 3, characteristic of spherically symmetrical systems. The limiting case of a stationary

plane wave acting on a *finite* plane-parallel reflector is considered, and the formula here developed is reconciled with that previously given by Brillouin.

534.7 2402

Auditory Sensation produced by Rectangular Waves.—R. Chochoille. (*Ann. Télécommun.*, June 1950, Vol. 5, No. 6, pp. 237–242.) Discussion of the results of an experimental study. The waveform of the sound waves resulting from application of square waves to an acoustic transducer depends largely on the ratio between the fundamental frequency of the applied square waves and the resonance frequencies of the transducer. The character of the sensation produced is distinct in the very low, low, medium and high-frequency ranges. In certain narrow frequency bands slight variation of frequency produces a marked change in sensation, i.e., intensity and general timbre. The ear is found to respond rather to the wave *envelope* and total *effective* amplitude than to the individual components of the sound spectrum.

534.78 : 621.395 2403

The Perception of Speech and its Relation to Telephony.—H. Fletcher & R. H. Galt. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, p. 327.) Correction to paper abstracted in 1844 of August.

534.833.4 2404

A Review of the Absorption Coefficient Problem.—H. J. Sabine. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 387–392.) The problem of discrepancies between measurements of acoustic absorption coefficient obtained by different workers is discussed from the viewpoint of the materials manufacturer. Suggestions are made for further theoretical and experimental investigations.

534.843 2405

Transient Sounds in Rooms.—D. Mintzer. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 341–352.) Laplace-transform methods are used for investigating the propagation of transient sound waves. In the one-dimensional case propagation of a plane wave in a rigid-walled tube is considered. The velocity potential for an arbitrary particle-displacement input is found as a series, each term of which represents the effect of a reflection from an end of the tube. In the three-dimensional case a spherical wave is considered in unbounded and variously bounded regions, and the case of a point source in a rectangular room is solved. An image method is used. Examples are calculated for both one- and three-dimensional systems.

534.844.1 : 621.3.015.33 2406

Pulse Statistics Analysis of Room Acoustics.—R. H. Bolt, P. E. Doak & P. J. Westervelt. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 328–340.) Reverberation time is not by itself an adequate index of the acoustic quality of a room, since it does not give information about the response to transients. To take account of the pulse-like nature of common sounds, an analytical technique has been developed in which the walls of the room are replaced by an infinite array of image sources; a statistical consideration of this array gives the long-term average response to transients. To illustrate the technique a description is given of experiments carried out in a rectangular room with hard plastered walls, using a sound source emitting 2-ms pulses of 3600-c/s damped waves.

534.846 : 621.396.712.3 2407

Rooms with Reverberation Time Adjustable over a Wide Frequency Band.—P. Arni. (*J. acoust. Soc. Amer.*, May 1950, Vol. 22, No. 3, pp. 353–354.) Description of a broadcasting studio at Helsinki having wall elements with variable absorption characteristics.

621.395.623.7 2408

A Contribution to the Design of Horn Loudspeakers.—J. Merhaut. (*Tesla tech. Rep., Prague*, Dec. 1949, pp. 41–43.) The high-frequency response may be improved by subdividing the throat of the exponential horn, since the phase differences between the sound waves emanating from different parts of the diaphragm may thereby be reduced. A new design described gives a 4.5-db improvement at 8 kc/s.

621.395.623.7 2409

A New Loudspeaker Combination.—H. Schmidt. (*Funk u. Ton*, May 1950, Vol. 4, No. 5, pp. 226–232.) A high-efficiency loudspeaker with a strong electromagnet for transient damping has a 'spherical-wave' modified exponential horn. In front of the light metal spherical membrane is a slotted acoustic cone for equalizing sound-path lengths in the neck of the horn, giving a further increase of the electroacoustic efficiency. With the associated filter circuit it is mounted above a bass-response loudspeaker which has a conical diaphragm of diameter 35 cm. The response curve of the combination is shown. It is nearly level between 50 c/s and 10 kc/s. Crossover occurs at 500 c/s.

621.395.623.8 : 621.398 2410

Remote Control of the Tesla RU Rack and Panel Public Address System.—L. Pravenec. (*Tesla tech. Rep., Prague*, Dec. 1949, pp. 33–40.) Panel units are described (*a*) for use at a main station, making remote control of up to 10 substations possible, and (*b*) for use at a substation, enabling it to accept remote control from a main station while retaining the possibility of independent operation.

621.395.625.3 + 681.84[.85] : 061.4 2411

Sound Reproduction.—(*Wireless World*, July 1950, Vol. 56, No. 7, pp. 255–258.) Short descriptions of equipment at the exhibition arranged by the British Sound-Recording Association in London, May 1950. In addition to disk, magnetic wire and tape, and film recorders, many examples of amplifiers, loudspeakers, pickups, microphones and auxiliary and test equipment were shown, as well as B.B.C. and Radio Luxembourg sound-recording vans.

681.85.001.4 2412

A Feedback-Controlled Calibrator for Phonograph Pickups.—J. G. Woodward. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 301–309.) The gramophone-pickup calibrator is an electromechanical device for imparting known and controllable lateral motions to the stylus of a pickup under test. The calibrator employs a dynamic driving system, and electromechanical feedback is used to secure a uniform response between 20 c/s and 20 kc/s. The absolute as well as the relative response of a pickup can be conveniently and quickly measured within this frequency range.

681.85.004.62 2413

Record and Stylus Wear.—G. H. H. Wood. (*Wireless World*, July 1950, Vol. 56, No. 7, pp. 245–248.) Neither low stylus pressure nor sapphire points which are dimensionally correct can, of themselves, provide a satisfactory solution to the problem of record wear. It is shown, with the aid of photomicrographs, that greatly prolonged stylus life and low record wear result from the use of a crystal pickup head with a correctly designed sapphire stylus so mounted that the coupling is comparatively flexible in the vertical direction. Vertical movement of the stylus is not transmitted to the pickup head and the system reduces the effective mass of the stylus to a very low value compared with that of conventional stylus systems.

621.395.625 + 534.862.4 **2414**

The Recording and Reproduction of Sound. (Book Review).—O. Read. Publishers: H. W. Sams & Co., Indianapolis, U.S.A., 1949, 364 pp., $5.00. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 136, 138.) The book brings together information which until now has been scattered in periodicals and instruction manuals; it is of interest more to the technician and the gramophone enthusiast than to the engineer. See also 632 of 1949 and back references.

AERIALS AND TRANSMISSION LINES

621.315.212 **2415**

Coaxial Cable and its Optimum Design.—P. Ya. Shinberov. (*Priroda*, Jan. 1949, No. 1, pp. 69–74. In Russian.) Cable theory is discussed and methods are indicated for determining the capacitance and attenuation for different types of cable. The ratio of the radii of the conductors for maximum dielectric strength is also determined. Multicore cables with several coaxial pairs are briefly considered.

621.315.34.011.4 **2416**

Capacity of a Pair of Insulated Wires.—W. H. Wise. (*Quart. appl. Math.*, Jan. 1950, Vol. 7, No. 4, pp. 432–436.) A method of calculating capacitance is given which is related to but involves less numerical computation than that noted in 660 and 1446 of 1946 (Craggs & Tranter). Certain analytical difficulties which arise when the insulating jackets are in contact are indicated.

621.392 **2417**

Unbalanced Terminations on a Shielded-Pair Line.—K. Tomiyasu. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 552–556.) The simultaneous propagation of balanced and unbalanced modes along a shielded-pair line results in an unbalanced component of current. This can be determined by comparing the different standing-wave distributions on the two conductors. Measurements of the components of waves reflected from unbalanced radiative terminations (e.g., end-coupled aerials) on a slotted shielded-pair line are described.

621.392.1 **2418**

The Effect of a Bend and Other Discontinuities on a Two-Wire Transmission Line.—K. Tomiyasu. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 679–682.) The effect is analysed by the vector-potential method, the equivalent-circuit elements being obtained by comparing the variable-line parameters near the bend with the conventional-line parameters found on an infinite line. Good agreement is found between theoretical and experimental values of the circuit elements for the bend and also for open-end and bridged-end lines. See also 28 of January (King & Tomiyasu).

621.392.26† : 621.3.09 **2419**

Propagation of the TM_{01} Mode in a Metal Tube containing an Imperfect Dielectric.—D. L. Hetrick. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 561–564.) Losses in both the metal wall and the dielectric are taken into account in this analysis, the subject being treated as a boundary-value problem. General expressions are derived for the attenuation and phase constant, and the percentage error introduced by (*a*) neglecting wall losses and (*b*) assuming total attenuation to be the sum of the dielectric and wall-loss attenuations is computed for a particular case.

621.392.26† : 621.392.52 **2420**

Ring Mode Filter for Type H_{11} Waves in Circular Waveguides.—Z. Szepesi. (*Onde élect.*, May & June 1950, Vol. 30, Nos. 278 & 279, pp. 230–234 & 293–298.) Experimental investigation of ring mode filters of different dimensions in a waveguide of diameter 8 cm, using a wavelength of 11 cm. Results are tabulated. Good reflection occurs when the circumference of the ring is slightly greater than the free-space wavelength. The characteristics of the filter are practically independent of its conductivity. Impedance of the ring varies linearly with its circumference, when the circumference is less than that required for resonance the impedance is capacitive; when greater, it is inductive. Bandwidth increases with the cross-section of the ring. Measured bandwidth is considerably greater than the value given by the theory of Feuer & Akeley (640 of 1949). Using a combination of two filters, $3\lambda_g/4$ spacing is the most effective, where λ_g is the wavelength in the waveguide. The characteristics of a filter may be determined from its distance from a filter of known characteristics when the transmission coefficient of the combination has its maximum value.

621.392.43 **2421**

A Tapered Line Termination at Microwaves.—G. J. Clemens. (*Quart. appl. Math.*, Jan. 1950, Vol. 7, No. 4, pp. 425–432.) The termination considered is a short-circuited section of coaxial line with a uniformly tapered metallic outer conductor and an inner conductor consisting of a glass tube coated with a thin resistive metal film. The distribution of voltage and current is investigated theoretically and the measured values of voltage s.w.r. for the termination over the range 990–3 968 Mc/s are compared with those calculated for an exponential line, which is considered in the analysis as a convenient approximation.

621.396.67 **2422**

The Effect of an Obstacle in the Fresnel Field on the Distant Field of a Linear Radiator.—G. A. Woonton. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 577–580.) An analytical method is developed for determining the errors due to diffraction which arise when measurements on microwaves are made by optical methods. The analysis is applied to the particular problem of determining the distant field of a horn radiator with the aperture of a large screen in front of it at an arbitrary angle. Satisfactory agreement is obtained between calculated and measured values (2133 above).

621.396.67 **2423**

Effect of a Finite Groundplane on Antenna Radiation.—A. Leitner & R. D. Spence. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 199.) Summary of American Physical Society paper. The field of a $\lambda/4$ dipole over a circular ground-plane is calculated exactly. Both the current in the ground-plane and the radiation at great distances are found. As the radius of the ground-plane is increased, the radiation resistance and the surface current oscillate about the values which characterize a $\lambda/4$ aerial above an infinite ground-plane, but the radiation pattern is entirely different. The results are in good quantitative agreement with the experimental results of Meier & Summers (2440 of 1949).

621.396.67 **2424**

The Directive Properties of Receiving Aerials.—E. Roubine. (*Onde élect.*, June 1950, Vol. 30, No. 279, pp. 259–266.) Full paper of which an abridged version was given in *C. R. Acad. Sci., Paris*, 3rd May 1950, Vol. 230, No. 18, pp. 1590–1592. Distinction is made between the case of rectilinear polarization and the general case of elliptical polarization. A simple fundamental formula is derived expressing the current in a receiving aerial as a function of the incident field, the load, and the radiating properties of the aerial in the direction from which the waves are received. The question of the

identity of the directive properties of aerials for transmission and reception is in general not well defined. The directivity for emission is, in fact, controlled by a single characteristic, while for reception this characteristic is altered by the intensity and polarization of the incident field, so that all comparisons of the directive properties necessitate an arbitrary convention in respect of the incident field. When considering gain, this convention is modified. The effect of polarization is discussed by means of an optical analogy. Current formulae for the absorption surface and the effective length of a receiving aerial are generalized.

621.396.67 : 621.397.6 **2425**

Ultra-High-Frequency Antenna and System for Television Transmission.—O. O. Fiet. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 212–227.) The construction and performance are described of an omnidirectional horizontal-polarization aerial consisting of two coaxial tubes. The inner one acts as a transmission line feeding groups of slot aerials in the outer tube by means of radial probes. A power gain of 17.3 db is obtained at 530 Mc/s.

An account is also given of the design and performance of the waveguide feed between the transmitter and the aerial, the vestigial-sideband filter and a notch diplexer which enables the sound and vision signals to be fed along the common transmission line.

The aerial system was developed for operation at Bridgeport, Connecticut [1795 of July (Guy, Seibert & Smith)].

621.396.67.029.62/.63 **2426**

Experimental Investigations on Wide-Band Metre- and Decimetre-Wave Aerials.—K. Lamberts & L. Pungs. (*Fernmeldetech. Z.*, May 1950, Vol. 3, No. 5, pp. 165–173.) Study made in 1942 of the characteristics of single dipoles with reflectors. A greater bandwidth can be obtained by increasing the diameter when tubes are used as the dipole elements, or by the use of specially shaped flat elements. Circle diagrams show the influence of tube diameter, aerial length and reflector distance on the frequency dependence of the aerial input impedance.

621.396.671 : 621.3.011.2 **2427**

Input Impedance of Two Crossed Dipoles.—I. G. Chambers. (*Wireless Engr*, July 1950, Vol. 27, No. 322, pp. 209–211.) The mutual impedance is calculated by applying Carter's method; the input impedance is then found from a simple formula. These impedances are, to a good degree of approximation, expressible as simple functions of the angle between the dipoles.

621.396.671.029.63/.64 **2428**

Relations concerning Wave Fronts and Reflectors.—K. S. Kelleher. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 573–576.) Vector formulae are derived relating the incident and reflected wave fronts and the reflector surface. The analysis is applied to particular microwave problems, including the determination of the reflector surface which will transform an arbitrary incident wave front into a plane wave front.

621.396.677 **2429**

Rotatable Directive Antenna.—J. Bříza. (*Tesla tech. Rep., Prague*, Dec. 1949, pp. 10–32.) The apex of a rhombic aerial is attached by means of insulators to the rotatable head of a wooden mast, the other three junctions being attached by sectioned cables to carriages running on a circular track round the mast. The positions of the carriages, which form a symmetrical system, are controlled to alter the direction of transmission or reception and also to adjust the apex angle to suit different frequencies. The aerial is fed at its lowest point by twin cable which is carried round with it. Computed polar diagrams are compared with experimental results for scale models.

621.396.677 : 621.397.828 **2430**

TV Antenna Phase Control.—Carmichael. (*See* 2655.)

621.396.677.2 : 621.396.97 **2431**

Nine-Tower Broadcast Array.—C. W. Winkler & M. Brasseur. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 102–104.) Brief illustrated account, with details of phasing and aerial-tuning equipment, of the WDGY station at Minneapolis, which produces a radiation pattern with suppression over an angle of 247°.

621.396.67.029.64 **2432**

Aerials for Centimetre Wavelengths. [Book Review]—D. W. Fry & F. K. Howard. Publishers: Cambridge University Press, 1950, 172 pp., 18s. (*J. Brit. Instn Radio Engrs*, July 1950, Vol. 10, No. 7, p. vi.) "This book deals specifically with radiating systems for radar applications, but design principles are outlined in sufficient detail to enable the engineer to design a radiator for other applications."

CIRCUITS AND CIRCUIT ELEMENTS

517.41 : 621.3.016.352 **2433**

On the Representation of the Stability Region for Oscillation Phenomena by use of Hurwitz Determinants.—E. Sponder. (*Schweiz. Arch. angew. Wiss. Tech.*, March 1950, Vol. 16, No. 3, pp. 93–96.)

621.3.012.2 **2434**

Classes of Circle Diagrams.—C. E. Moorhouse. (*J. Instn Engrs, Aust.*, March 1950, Vol. 22, No. 3, pp. 69–74.) Consideration of the properties of a general 4-pole network under specified terminal conditions leads to a general method of establishing the conditions for the existence of circle diagrams. Two classes of diagrams are discussed; variants of these include many of the circle diagrams used in electrical engineering.

621.316.8.029.55/.62 **2435**

Behavior of Resistors at High Frequencies.—G. R. Arthur & S. E. Church. (*TV Engng, N.Y.*, June 1950, Vol. 1, No. 6, pp. 4–7.) The variation of resistance with frequency is discussed for various types of resistor by consideration of circuit equivalents which include a capacitive element. Theoretical results agree with measured values for commercial resistors in the frequency range 5–60 Mc/s to within 10%. Except possibly for special h.f. resistors, the effective resistance of resistors decreases more rapidly with frequency the higher the value of the d.c. resistance. For the same d.c. resistance, the smaller the physical dimensions the better are the h.f. characteristics. Resistors using a carbon coating on insulating material were found better for h.f. work than either carbon-block or composition resistors.

621.318.371 **2436**

Calculation of the Inductance of Circular Conductors and Single-Layer Close- or Open-Wound Solenoids.—W. Keller. (*Bull. schweiz. elektrotech. Ver.*, 27th May 1950, Vol. 41, No. 11, pp. 442–450. In German.) A method of calculation is developed and a series of equations derived. Curves are plotted from which the value of inductance is readily determined when length, cross-section, etc., are known.

621.318.5 **2437**

Magnetic Triggers.—An Wang. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 626–629.) Magnetic cores with fairly rectangular hysteresis loop are used in

a trigger device in which magnetic fluxes serve instead of electrical currents to indicate the two stable states. The magnetic-flux polarity can be detected without mechanical motion. The construction and operation of several types of magnetic trigger are described. See also 1183 of May (An Wang & Way Dong Woo).

621.319.4 **2438**

The Theory of a Three-Terminal Capacitor.—R. E. Corby. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 635–636.) Equations are derived for the insertion loss of a 3-terminal capacitor and their solution gives results in agreement with experiment. The capacitor is assumed to function like a transmission line and the constants of the equivalent line are determined as a function of frequency. Skin effect and proximity effect are taken into consideration, and curves are plotted to facilitate computation.

621.389 : 681.142 **2439**

A Fast Multiplying Circuit.—Chance, Busser & Williams. (*See* 2558.)

621.392 : 512.831 **2440**

An Introduction to the Matrix Method of Solving Electrical-Network Problems.—R. Guertler. (*J. Instn Engrs, Aust.*, March 1950, Vol. 22, No. 3, pp. 46–52.) The fundamental principles of matrix algebra are outlined and simple working rules are given. The transformation matrices of series-impedance and shunt-admittance 4-pole networks are derived and these matrices, together with the rules of matrix algebra, are applied to discussion of networks in cascade, of L, T and Π networks, and to calculation of the frequency response of a class-B modulator, this calculation being considerably simpler than that by ordinary methods, as given in Appendix 2. A simple application of matrix methods is given in Appendix 1, where the conditions are derived for the current or voltage in a circuit to remain constant under varying load.

621.392 : 517.512.2 **2441**

Application of Fourier Transforms to Variable-Frequency Circuit Analysis.—A. G. Clavier. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 159–163.) Reprint. See 307 of February.

621.392 : 517.512.6 **2442**

A Note on the Solution of Certain Approximation Problems in Network Synthesis.—R. M. Fano. (*J. Franklin Inst.*, March 1950, Vol. 249, No. 3, pp. 189–205.) A method is given for the determination of appropriate functions to define the amplitude characteristics of networks when certain ideal responses are to be approached within specified limits. The method is based on simplification of the geometry of the problem by transformation in the complex plane.

621.392 : 621.3.016.35] : 681.142 **2443**

Mathematical Problems of Feedback.—H. Freudenthal. (*Ned. Tijdschr. Natuurk.*, Nov. 1949, Vol. 15, No. 11, pp. 275–281.) Paper given at the Symposium on Modern Calculating Machines, Amsterdam, May 1949. From both the mathematical and the physical viewpoints, it is preferable to treat feedback circuit problems by the method of continuous rather than discrete iteration. Analysis establishes the necessary and sufficient conditions for convergence and hence for circuit stability.

621.392.011.2 **2444**

Reciprocity between Generalized Mutual Impedances for Closed or Open Circuits.—A. G. Clavier. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 152–158.) Reprint. See 1358 of June.

621.392.43 **2445**

Wideband Series-Parallel Transformer Design.—V. C. Rideout. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 122–162.) Formulae for obtaining maximum flatness of the response curve are derived from filter-theory considerations. The circuit constants of a matching transformer to connect a coaxial line to the first valve of an amplifier are calculated numerically.

621.392.5 **2446**

The Bridged-T Network and its Properties.—W. Taeger. (*Funk u. Ton*, May 1950, Vol. 4, No. 5, pp. 253–259.) Mathematical analysis deriving expressions for attenuation and phase constant.

621.396.611.1 **2447**

Oscillation Phenomena in a Circuit with a Discontinuous Linear Characteristic.—G. J. Elias & S. Duinker. (*Tijdschr. ned. Radiogenoot.*, May 1950, Vol. 15, No. 3, pp. 79–91. In Dutch, with English summary.) A series circuit of negligible resistance is considered which comprises a capacitor and an inductor with a core material such as mumetal or permalloy having a sharp knee in its magnetization curve. To facilitate analysis, an approximation to the curve is used which consists of three straight lines. In such a circuit forced subharmonic oscillations can be maintained, but transition phenomena occur when the amplitude of the applied e.m.f. is great enough to extend the operation beyond the knee of the curve. When operation is largely in the saturation region, the initial amplitude of the free oscillations is related to the magnitude of the corresponding transition; the oscillations are damped, owing to hysteresis losses. Each transition adds a fresh inner loop to the main hysteresis loop, corresponding to a pair of new real branch-points in the hyperelliptic expression for the oscillations. See also 582 of March.

621.396.611.4 : 538.56 **2448**

Forced Oscillations in a Spherical Cavity Resonator.—A. A. Piotrovski. (*Zh. tekh. Fiz.*, March 1950, Vol. 20, No. 3, pp. 282–294. In Russian.) Mathematical discussion of the excitation of a spherical cavity resonator by a single turn of wire at its centre. An equivalent oscillatory circuit is derived and methods are indicated for determining its impedance and main parameters such as Q, damping factor and loss resistance.

621.396.611.4 : 621.396.615.142.2 **2449**

Wide-Range Tunable Waveguide Resonators.—W. W. Harman. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 671–679.) See 2476 of 1949.

621.396.615.12 **2450**

LC Oscillators and their Frequency Stability.—J. Vackář. (*Tesla tech. Rep., Prague*, Dec. 1949, pp. 1–9.) Factors affecting stability are considered and their specific effects tabulated; the mechanical and electrical design and construction of highly stable circuits are discussed. A general analysis is given of the oscillator circuit and a formula for change of frequency with change of valve capacitance is derived. Known variable-frequency oscillators are reviewed and new circuits used in Tesla broadcasting transmitters and having a tuning range of 1.5 : 1 are described.

621.396.615.14 : 621.385.3 **2451**

Feedback in Very-High-Frequency and Ultra-High-Frequency Oscillators.—F. J. Kamphoefner. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 630–632.) A study of feedback considerations in low-power negative-grid triode oscillators for the frequency range 100–1 000 Mc/s. Discussion is mainly confined to oscillators using a single tuned circuit between grid and

anode in the modified Colpitts circuit in which feedback is provided by the valve interelectrode capacitances. The optimum feedback conditions are deduced and the analysis is applied to several typical oscillators.

621.396.615.14 : 621.385.3 2452

Ultra-High-Frequency Triode Oscillator using a Series-Tuned Circuit.—J. M. Pettit. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 633–635.) Analysis of a modified Colpitts circuit for a particular triode gives, as a function of frequency, the series resistive and reactive components of the two-terminal impedance looking at the grid-anode terminals. Use of a series-tuned external circuit instead of the usual parallel-tuned circuit permits oscillation above the self-resonance frequency of the triode, provided transit-time effects are unimportant.

621.396.615.17 2453

Linear Sweep Generation.—D. Sayre. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 171..175.) Linear positive or negative sweeps are produced by charging an electronically switched capacitor through a constant-current triode. The linearity obtained is between that of the bootstrap circuit and that of the Miller feedback circuit.

621.396.615.17 2454

Cathode-Coupled Multivibrator Operation.—K. Glegg. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 655–656.) An approximate analysis results in an expression for the duration of the output pulse in terms of the values of the circuit elements. A series expansion shows that the duration of this pulse is nearly a linear function of one of the circuit voltages.

621.396.615.17 : 621.397.62 2455

A Hard-Valve Time-Base.—C. H. Banthorpe. (*Electronic Engng.*, Aug. 1950, Vol. 22, No. 270, p. 339.) Full circuit details and description of the action of a linear frame-timebase in which the start of the scan is triggered and which is unaffected by line pulses which may be introduced owing to imperfect line/frame synchronization separation.

621.396.645 2456

Design of Cathode-Coupled Amplifiers.—S. G. F. Ross. (*Wireless Engr*, July 1950, Vol. 27, No. 322, pp. 212–215.) Previously published theoretical work on the subject is reviewed, and a new rigorous analysis is presented. Experimental results indicate that this analysis can be relied on within the accuracy of published valve data.

621.396.645 2457

Modern Methods of Power Amplification.—M. Strutt. (*Bull. schweiz. elektrotech. Ver.*, 10th June 1950, Vol. 41, No. 12, pp. 479–484. In German.) Definition of power gain and discussion of its application in valve, semiconductor, magnetic and amplidyne amplifiers.

621.396.645 : 621.316.722.078.3 2458

Stabilization of Wide-Band Direct-Current Amplifiers for Zero and Gain.—E. A. Goldberg. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 296–300.) Stabilization is obtained through the application of a mechanical chopper to detect any zero offset error voltage. The circuit is such that the stabilization device does not alter the h.f. response characteristics of the amplifier. Primary application has been in the field of analogue electronic computers.

621.396.645 : 621.385.3 : 621.315.592† 2459

High-Frequency Operation of Transistors.—C. B. Brown. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 81–83.) Dispersion in transit-time values, resulting from differences in lengths of flow paths between emitter and collector, is the primary cause of loss of h.f. response. Magnetic bias of appropriate sign applied at right angles to the plane containing the axes of the collector and emitter electrodes reduces transit time and dispersion, with consequent increase of frequency range. The circuit of a 23-Mc/s amplifier for testing the h.f. response is described, the transistor being biased by a field of strength 16 000 lines/in². A gain of 8 is obtained between 1 000-Ω input and output. Time and temperature stability of the transistors are discussed briefly. See also 2089 of August.

621.396.645 : 621.396.61 2460

Maximum Tank Voltage in Class-C Amplifiers.—L. E. Dwork. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 637–644.) Theoretical considerations are presented to explain the frequent appearance in class-C amplifiers of r.f. anode voltages which are greater than the d.c. anode voltage. A method is developed for predicting the magnitude of this r.f. voltage under any given set of conditions. The method is verified experimentally for a particular case.

621.396.645.37 2461

Intermediate-Frequency Gain Stabilization with Inverse Feedback.—G. F. Montgomery. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 662–667.) "Improvement in gain stability is related to the number of cascaded stages, the stage gain, and the magnitude of the feedback. A circuit is described which uses feedback over a pair of cascaded stages. Generalized selectivity curves for this feedback couple are shown, and the design procedure is outlined."

621.396.645.37 2462

General Formulae for Feedback Amplifiers.—F. Job. (*Ann. Télécommun.*, Dec. 1948, Vol. 3, No. 12, pp. 436–444.) The general theory of linear networks including amplifying valves has been given in a very complete manner by Bode (3381 of 1948). A simple demonstration is here given of the most important formulae of Bode's theory. Examples and applications illustrate the extreme generality of the formulae.

621.396.645.37 2463

More about Positive Feedback.—T. Roddam. (*Wireless World*, July 1950, Vol. 56, No. 7, pp. 242–244.) When applied to those stages of an amplifier in which distortion is not inherently large, positive feedback permits a considerable increase in overall gain with little increase in overall distortion. The negative feedback applied to the whole amplifier may then be increased, reducing the overall gain to the original level with a considerable reduction in the overall distortion. Positive feedback increases phase shift, making it more difficult to keep the overall system stable. Its use should therefore be confined to the frequency range over which it is particularly needed.

621.396.645.371 2464

Negative-Feedback Amplifiers.—J. E. Flood. (*Wireless Engr*, July 1950, Vol. 27, No. 322, pp. 201–209.) Negative-feedback amplifiers designed to obtain a flat response curve may give an oscillatory response to transients if the feedback exceeds a certain amount. The present analysis shows that by suitably adjusting the time constants for the various stages and by modifying the feedback path, critical damping with resulting absence of overshoot for transients can be attained together with a flat response curve throughout the frequency band for both 2-stage and 3-stage amplifiers. Experimental results are in fair agreement with calculated values.

519.242 : 621.3 2465

The Extrapolation, Interpolation and Smoothing of Stationary Time Series, with Engineering Applications. [Book Review]—N. Wiener. Publishers: John Wiley & Sons, New York, 1949, 163 pp., $4.00. (*J. Franklin Inst.*, March 1950, Vol. 249, No. 3, p. 259.) This was issued as a classified report during the war. "The theory set forth is widely used and has guided modern thinking in filter and predictor theory."

621.314.3† 2466

The Magnetic Amplifier. [Book Review]—J. H. Reyner. Publishers: Stuart & Richards, London, 119 pp., 15s. (*Wireless Engr*, July 1950, Vol. 27, No. 322, p. 216.) The presentation is mainly descriptive, where mathematical reasoning is used it is expressed as far as possible in terms of elementary a.c. theory.

GENERAL PHYSICS

53.081 + 621.3.081 2467

The Introduction of the Giorgi System of Units.—H. König, M. Krondl & M. Landolt. (*Tech. Mitt. schweiz. Telegr.-TelephVerw.*, 1st May 1950, Vol. 28, No. 5, pp. 207–208. In French and German.) Corrections to paper noted in 1125 of May, for which the U.D.C. number should be as above.

53.081.5 2468

On the Theory of the Dimensions of Physical Quantities.—M. Landolt. (*Bull. schweiz. elektrotech. Ver.*, 10th June 1950, Vol. 41, No. 12, pp. 473–479. In German.) Review of different definitions of dimension and proposal of a new variant.

535.34-1 : [546.28 + 546.289 2469

Theory of Infra-Red Absorption in Silicon and Germanium.—J. Bardeen. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 216.) Summary of American Physical Society paper.

535.37 2470

Scattering and Absorption of Luminescence Light in Polycrystalline Luminescent Layers under Excitation by High-Energy Quantic and Corpuscular Rays.—I. Broser. (*Ann. Phys., Lpz.*, 16th Jan. 1950, Vol. 5, Nos. 6/8, pp. 401–416.) Experiments with a ZnS-Cu phosphor, using α particles, γ- and X-rays for excitation, indicate that the scattering and absorption factors for the luminescence light are independent of the type of excitation. Measurements of the effect of grain size in the phosphor layer on the scattering and absorption are described and discussed.

535.42 2471

Diffraction by a Plane Screen.—E. T. Copson. (*Proc. roy. Soc. A*, 7th July 1950, Vol. 202, No. 1069, pp. 277–284.) Boundary conditions involved when solving the problem of diffraction by a perfectly conducting plane screen using the integral-equation method are analysed. Theorems given in a previous paper (*ibid*, 1949, Vol. 186, pp. 100–118) are recast in a form which meets the criticism of Bouwkamp (2772 of 1948), and the integral-equation method is applied to the problem of diffraction by a half-plane. The form of the arbitrary function of integration is adjusted to limit the order of the singularity at the boundary.

535.42 2472

The Edge Condition in the Theory of the Diffraction of Electromagnetic Waves at Perfectly Conducting Plane Screens.—J. Meixner. (*Ann. Phys., Lpz.*, 19th Sept. 1949, Vol. 6, pp. 2–9.) The edge condition is based on the physically plausible requirement that the e.m. energy density in the neighbourhood of the edge be integrable, i.e., that the field energy in each finite volume be finite. A particularly simple mathematical expression of the edge condition is given by the Debye e.m. field potentials. In the diffraction of sound waves at the edge of a screen the e.m. edge condition corresponds to the requirement that at the edge the sound pressure must remain finite.

535.42 2473

Energy Flow in the Near Field of a Diffracting Edge.—W. Braunbek. (*Ann. Phys., Lpz.*, 19th Sept. 1949, Vol. 6, pp. 53–58.) For the region near the edge (distance $\ll \lambda$) the field can be found very simply by application of Sommerfeld's solution for diffraction at a semi-infinite plane. For the special case of perpendicular incidence on an infinitely thin, perfectly conducting screen, the electric vector being parallel to the diffracting edge, the phase surfaces of the field near the edge are calculated and also the surfaces of energy flow, which to a first approximation are confocal parabolic cylinders with the edge as focal line.

537.226.001.11 : 546.431.82-3 2474

Electronic Theory of Ferroelectrics.—E. T. Jaynes & E. P. Wigner. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 213–214.) Summary of American Physical Society paper.

537.311.1 : 537.311.32/.33 2475

Conduction Electrons in Non-Metallic Solids.—H. Fröhlich. (*Research, Lond.*, May 1950, Vol. 3, No. 5, pp. 202–207.) A review of the action of electrons in substances which in their normal state are nonconductors, including consideration of various processes where the conduction-electron concentration varies with time. The problems of polarization, self-trapping, and mean free path in crystals are discussed, assuming the number of interelectron collisions to be negligible. The increase of conductivity produced by a strong field and the decay after excitation by an ionizing radiation should be governed by the same time constant.

537.311.1 : 621.315.592† 2476

Potential Fluctuations in Homogeneous Semiconductors.—H. M. James & G. W. Lehman. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 216.) Summary of American Physical Society paper.

537.311.1 : 621.315.592† 2477

On the Theory of Noise in Semiconductors.—R. L. Petritz & A. J. F. Siegert. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 215–216.) Summary of American Physical Society paper.

537.311.3 + 621.315.592† 2478

Electrical Conductivity.—Roulaud. (*See* 2543.)

537.312.8 2479

Effect of Magnetic Fields on Conduction: 'Tube Integrals'.—W. Shockley. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 191–192.) The mathematical expression for the effect of a magnetic field on conduction in a material can be reduced to integrals by using 'tubes', which are specified regions in the Brillouin zone. The case of simple closed tubes, which are of interest in relation to semiconductors, is discussed. An expression for the total electron current is derived, evaluation of which may prove a means of determining the energy-surface parameters for Ge from magnetoresistance measurements on single crystals.

537.312.8 2480

Theory of Magnetic Resistance Effects in Metals.—M. Kohler. (*Ann. Phys., Lpz.*, 19th Sept. 1949, Vol. 6, pp. 18–38.) Approximate formulae are derived for the change of the electrical and the thermal resistance of a

metal when a transverse magnetic field is applied. Theoretical results are compared with experimental values.

537.525.5 : 538.6 **2481**

Supersonic Wind at Low Pressures Produced by Arc in Magnetic Field.—H. C. Early & W. G. Dow. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 186.) Discussion of the effects of a transverse magnetic field on a low-pressure gas discharge. When the arc is in a large unconfined region, e.g., a vacuum chamber of 1 cubic metre, wind effects are observed. Power input and current density become many times larger; gas temperature is generally low because of the cooling effect of the wind; ion mobility is little reduced; equipotentials occur at skewed positions. In the case of an arc between a copper cylinder and surrounding ring, an axial magnetic field causes the arc to revolve at a speed of about 17 000 r.p.s. under particular conditions. The air inside the cylinder also revolves, but at a slower rate, its speed being estimated at 3 000–4 500 m.p.h.

537.562 **2482**

Dispersive Power and Natural Oscillation of an Ionized Gas.—G. Burkhardt. (*Ann. Phys., Lpz.*, 19th Jan. 1950, Vol. 5, Nos. 6/8, pp. 373–380.) The dispersion theory for an ionized gas can be derived from the Lorentz theory for a neutral gas if the natural frequency of the polarization electrons is assumed equal to a certain limiting frequency, which is the natural frequency of the oscillating plasma. This theory indicates unconditionally that the Lorentz polarization term should not appear in the dispersion formula for a plasma. See also 738 of 1944 (Darwin).

538.114 **2483**

Time Decrease of Magnetic Permeability in Alnico.—R. Street & J. C. Woolley. (*Proc. phys. Soc.*, 1st July 1950, Vol. 63, No. 367B, pp. 509–519.)

538.221 : 538.569.4.029.64 **2484**

Ferromagnetic Resonance in Manganese Ferrite and the Theory of the Ferrites.—C. Guillaud, W. A. Yager, F. R. Merritt & C. Kittel. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 181.) Discussion of observations of resonance absorption at 24 164 Mc/s in polycrystalline $Fe(MnFe)O_4$ at room temperature.

538.221 : 538.569.4.029.64 **2485**

Ferromagnetic Resonance in Single Crystals of Nickel Ferrite.—W. A. Yager, J. K. Galt, F. R. Merritt, E. A. Wood & B. T. Matthias. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 214.) Summary of American Physical Society paper.

538.221 : 539.23 **2486**

Thin Ferromagnetic Films.—M. J. Klein & R. S. Smith. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 214.) Summary of American Physical Society paper.

538.221.001.11 **2487**

Theory of Magnetic Dispersion in Ferrites.—C. Kittel. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 214.) Summary of American Physical Society paper.

538.521 : 517.948.32 **2488**

The Induction of Electric Currents in a Uniform Circular Disk.—A. A. Ashour. (*Quart. J. Mech. appl. Math.*, March 1950, Vol. 3, Part 1, pp. 119–128.) By regarding a uniform disk, or any symmetrically conducting surface of revolution, as composed of an infinite number of coaxial annular circuits, the determination of the electric currents induced by an external field is reduced to the solution of a Fredholm integral equation. Two methods of solving this equation are described.

538.566 + [537.226.2 : 546.217 **2489**

The Velocity of Electromagnetic Waves and the Dielectric Constant of Dry Air.—J. V. Hughes. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 222.) Summary of American Physical Society paper. To obtain agreement between the commonly accepted value of the velocity of light (299 775 km/s) and the mean (299 790 km/s) of six recent determinations of the velocity of radio waves, it would be necessary to use a value of 1.000 48 for the dielectric constant k of air when correcting measurements in air to vacuo. Values of k obtained by various experimenters, using frequencies from those of light waves down to 1 Mc/s, range from 1.000 572 to 1.000 60. The source of the discrepancy must consequently be sought elsewhere. See also 1751 of July (Essen).

538.566 : 537.562 **2490**

Electro-Magneto-Ionic Optics.—V. A. Bailey. (*J. roy. Soc. N.S.W.*, 1948, Vol. 82, Part 2, pp. 107–113.) Theoretical study of the modes of propagation of electric waves in a medium composed of electrons, positive ions and molecules (or atoms) in the presence of static electric and magnetic fields. The solution for plane waves is found in a general form which specifies the refractive indices and attenuation coefficients (positive or negative) as a function of frequency. The theory has application to the ionosphere, to the solar atmosphere and to discharge tubes. A deduction from it is that certain waves will grow as they progress in space or with passage of time; this suggests a possible explanation of the origin of stellar, solar and ionospheric noise. See also 2785 of 1949.

538.632 : 621.315.592† **2491**

Theoretical Hall-Coefficient Expressions for Impurity Semiconductors.—V. A. Johnson & K. Lark-Horovitz. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 176–177.)

538.652 : 621.317.4 **2492**

A New Method of Measuring Magnetostriction. Application to the Ferrite of Cobalt.—L. Weil, M. Gallay & P. Poensin. (*C. R. Acad. Sci., Paris*, 17th July 1950, Vol. 231, No. 3, pp. 224–226.) For measurements under widely different conditions of temperature or material, a method using a simple strain gauge of the resistance type has particular advantages. Accuracy of measurement is within about 1%, but the method can be applied to material of any shape and its simplicity recommends it for investigations in connection with industrial equipment. Results obtained for Co ferrite, made highly magnetostrictive by cooling for 18 hours after heat treatment at 1 200°C, are presented.

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

061.3 : [55 + 621.396.11 **2493**

Summary of Proceedings of Australian National Committee of Radio Science, U.R.S.I., Sydney, January 16–20, 1950.—(*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 191–210.) Summaries are given of 33 papers presented at the conference.

523.746 **2494**

Final Relative Sunspot-Numbers for 1949.—M. Waldmeier. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 211–213.)

523.746 **2495**

Provisional Sunspot-Numbers for January to March, 1950.—M. Waldmeier. (*J. geophys. Res.*, June 1950 Vol. 55, No. 2, p. 217.)

537.562 : 538.566 2496

Electro-Magneto-Ionic Optics.—Bailey. (*See* 2490.)

538.711 2497

Measurement of the Earth's Magnetic Field at High Altitudes at White Sands, New Mexico.—E. Maple, W. A. Bowen & S. F. Singer. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 115–126.) Measurements by means of a total-field magnetometer fitted in an Aerobee rocket showed that at a height of 368 000 ft the decrease in field strength was 28 milligauss. The results for the whole flight agree to within 2 milligauss with calculations based on the dipole theory. No evidence of the existence of magnetic fields due to current sheets was obtained.

550.384 2498

International Data on Magnetic Disturbances, Fourth Quarter, 1949.—J. Bartels & J. Veldkamp. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 214–216.)

550.384 2499

Cheltenham Three-Hour-Range Indices *K* for January to March, 1950.—R. R. Bodle. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, p. 217.)

550.385 2500

Principal Magnetic Storms (Oct. 1949–March 1950).—(*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 218–220.)

550.385 : 551.594.52 2501

Development of a Magnetic Storm: The Southward Shifting of the Auroral Zone.—T. Nagata. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 127–142.) "The southward extension with the increased intensity of disturbance in the northern auroral zone is derived hour by hour for the geomagnetic storm of April 30, 1933."

551.510.535 2502

An Approach to the Approximate Solution of the Ionosphere Absorption Problem.—J. E. Hacke, Jr. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 683–684.) Discussion on 3115 of 1948.

551.510.535 2503

The Diurnal Variation of the Vertical-Incidence Ionospheric Absorption at 150 kc/s.—A. H. Benner. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, p. 685.) Measurements of the virtual height of the layer and the relative amplitudes of ground pulse and first and second echoes enable the diurnal variation of $|\log \rho|$ to be plotted. Marked absorption-curve transitions occur at ground sunrise and sunset. When $\log |\log \rho|$ is plotted against $\log \cos \chi$ (where χ is the sun's zenith angle), approximately straight lines are obtained for the morning and afternoon periods, the slopes being 0.675 and 0.76 respectively.

551.510.535 2504

Travelling Disturbances in the Ionosphere.—G. H. Munro. (*Proc. roy. Soc. A*, 7th July 1950, Vol. 202, No. 1069, pp. 208–223.) The motion of disturbances of the vertical distribution of F region ionization density has been investigated by means of synchronized signals from three spaced common-frequency pulse transmitters. *P'f* data from Sydney, Brisbane and Canberra show that the larger disturbances can travel 900 km without major change in type or in velocity, which ranges from 5 to 10 km/min. Quasicyclical variations of ionization density with periods of 10–60 min are found which show a progressive phase lag with decrease in height. The magnitude of the disturbance appears, in general, to decrease with decrease of the period. The mean direction of horizontal motion is about 20° E of N in winter and about 110° E of N in summer, the changes in direction occurring rather abruptly near the equinoxes. Some of the effects observed by Wells, Watts & George (3279 of 1946) may be due to disturbances of the type here considered.

551.510.535 : [537.568 + 533.15 2505

Diffusion in the Ionosphere.—M. H. Johnson & E. O. Hulburt. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 222.) Summary of American Physical Society paper. The nonlinear differential equations relating the ionic density in the atmosphere to the rate of ionization by solar radiation and the loss of ions by recombination and diffusion, have been integrated on the Naval Research Laboratory computer and ionic-density curves have been obtained. Diffusion broadens the curve, thereby changing the relations between real and virtual heights, and shifts its maximum downwards, modifying the dependence of the height of the ionized region on the solar zenith angle.

551.510.535 : 621.396.11 2506

Ionosphere Observations at 50 kc/s.—J. N. Brown & J. M. Watts. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 179–181.) A high-power pulse transmitter giving an output of about 200 kW into a large loop aerial has been used at Sterling, Virginia, by the C.R.P.L. for measurements of the height of the reflecting layer for signals of frequency about 50 kc/s. The record for one day is reproduced, the virtual height of the reflecting layer being about 80 km. Height changes are not great and morning and evening peaks do not seem to occur every day. Double echoes are sometimes observed.

551.594.21 2507

The Free Electrical Charge on Precipitation Inside an Active Thunderstorm.—R. Gunn. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 171–178.) An induction method was used in an aircraft to measure the charges on individual droplets. Results are given for seven different levels in the cloud. With the freezing level at 14 000 ft, the maximum electrification occurred at about 7 500 ft and at a temperature of 10°C, the electric field strength at the surface of the droplets being a large fraction of the dielectric strength of air.

551.594.6 2508

The Fine Structure of Atmospherics: Ionospheric and Meteorological Applications of Type 4.—R. Rivault. (*C. R. Acad. Sci., Paris*, 22nd May 1950, Vol. 230, No. 21, pp. 1846–1847.) Daily recordings made at Poitiers during October 1949 enable the investigation of type-4 atmospherics to be carried further (see 2519, 2520 and 2521 of 1948). Oscillograms corresponding to sources in moving air masses exhibit rounded peaks, whereas those corresponding to sources in stationary air masses show a true short pulse clearly separated from its echoes. The normal value of *h*, the height of the reflecting layer, is found to be 75 km, with variations up to 12 km during the period 1700–2100. Uniformity of observations of atmospherics from different directions leads to the view that the D region is homogeneous and parallel to the ground. On days when large time variations were observed magnetic storms were also recorded.

521.03 2509

Some Recent Researches in Solar Physics. (Book Review)—F. Hoyle. Publishers: Cambridge University Press, London & New York, 1949, 134 pp., 12s. 6d. or $3.00. (*Science*, 21st April 1950, Vol. 111, No. 2889, p. 414; *Quart. J. R. met. Soc.*, Jan. 1950, Vol. 76, No. 327, p. 112.) "This book in the new series of Cambridge Monographs on Physics deals mainly with Hoyle's own recent work on the corona and chromosphere . . ."

Terrestrial phenomena directly influenced by the sun, and the emission of radio waves from the sun, are dealt with.

LOCATION AND AIDS TO NAVIGATION

527.5 : 518.12 2510

The Computation of Great-Circle Bearings and Distances.—G. Millington. (*Marconi Rev.*, 3rd quarter 1950, Vol. 13, No. 98, pp. 89–101.) To avoid the necessity of using seven-figure logarithms to obtain four-figure accuracy when using the standard formulae, trigonometrical transformations are used, a simplified rule of signs is adopted and the resulting computation is presented in a standard tabular form.

621.396.9 : 551.578.1 2511

The Effect of Rain on Marine Radar Echoes.—S. E. Barden. (*Marconi Rev.*, 3rd quarter 1950, Vol. 13, No. 98, pp. 102–109.) The failure of p.p.i. radar gear to detect targets when heavy rain is falling is analysed and curves are given to assist operators to determine the approximate ranges within which target echoes should be obtainable under different conditions.

621.396.933 2512

A Simple Localizer.—J. W. Alexander. (*Tijdschr. ned. Radiogenoot.*, July 1949, Vol. 14, No. 4, pp. 119–133. Discussion, p. 134.) Critical discussion of the SCS51 instrument landing system, and description of the Schiphol installation, in which an electrical method of modulation is used. It is suggested that P.I.C.A.O. specifications be redrafted to give a course angle of 2.5° on either side of the true direction.

621.396.933 2513

ILS–2 Instrument Landing Equipment.—R. A. Hampshire & B. V. Thompson. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 112–122.) A description of equipment which complies with P.I.C.A.O. requirements. The localizer, operating in the 108–112-Mc/s band, provides a beam along the runway and extending for at least 25 nautical miles, the two halves of the beam being modulated at 90 c/s and 150 c/s respectively. The glide path, adjustable from 2° to 4°, operates in the 329–335-Mc/s band, modulating frequencies of 90 c/s and 150 c/s being again used. Three marker beacons, all on 75 Mc/s but with different modulation frequencies, give distance indication. Speech transmission from the localizer can be made without interrupting its course modulation. Monitor and control circuits have been specially designed to ensure reliability of operation.

621.396.933 2514

Characteristics and Adjustment of 335-Mc/s Equisignal Glide Slopes.—S. Pickles. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 140–151.) Different factors influencing the radiated signals are examined with a view to improved performance and increased safety of operation.

621.396.933 2515

A Source of Error in Radio Phase-Measuring Systems.—R. Bateman, E. F. Florman & A. Tait. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 612–614.) When a mobile transmitter was moved between two points over different particular paths around reradiating structures, the measured total phase changes differed by $2n\pi$ radians, where n is an integer. If reradiation from a reflector is of the same order of magnitude as the radiation from an aerial, analysis of the resultant field shows that singularities occur and each traverse of a closed path around a point of singularity gives a total phase change of 360°.

621.396.933 2516

An Analysis of Some Anomalous Properties of Equiphase Contours.—G. A. Hufford. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 614–618.) Further investigation of cases, of importance in radio surveying or navigation systems, where the phase at certain points may be multivalued (see 2515 above).

621.396.9 2517

British Standard 204 : 1943. Supplement No. 4, Glossary of Terms used in Radar. (Book Notice)—Publishers: British Standards Institution, London, 1950, 8 pp., 2s. (*Brit. Stand. Instn Mon. Inform. Sheet*, June 1950, p. 1.)

MATERIALS AND SUBSIDIARY TECHNIQUES

531.788 2518

A Philips-Type Ionization Gauge for Measuring of Vacuum from 10^{-7} to 10^{-1} mm of Mercury.—E. C. Evans & K. E. Burmaster. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 651–654.) Description and detailed diagrams showing the construction of a modified gauge. For an account of an instrument giving similar performance see 1423 of June (Penning & Nienhuis).

535.215 : 546.23 2519

Photoconductivity in Amorphous Selenium.—P. K. Weimer. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 171.) Experimental results are given which indicate that the red amorphous form of Se is photoconductive and possesses properties very different from those of the common metallic form and of the red monoclinic-crystal form.

535.215 : 546.23 2520

Electron-Bombardment-Induced Conductivity in Selenium.—L. Pensak. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 171–172.) An account of measurements on evaporated films of red amorphous Se.

535.37 : 546.42.221 2521

Two Infra-Red-Sensitive SrS Phosphors with Zn Dominant Activator.—D. S. Bersis. (*J. opt. Soc. Amer.*, May 1950, Vol. 40, No. 5, p. 335.)

535.37 : 546.46.45.284 2522

Variation of Emission Spectrum of Manganese-Activated Zinc Beryllium Silicate with Decay Time.—J. H. Schulman, C. C. Klick & R. J. Ginther. (*J. opt. Soc. Amer.*, May 1950, Vol. 40, No. 5, pp. 337–338.)

535.37 : 546.47.31 2523

Sulphide in Zinc-Oxide Luminophors.—S. M. Thomsen. (*J. chem. Phys.*, May 1950, Vol. 18, No. 5, p. 770.) The presence of a small amount of ZnS, rather than free Zn, is responsible for the green luminescence of ZnO phosphors fired in hydrogen.

535.37 : 546.472.21 2524

Comparison of the Luminescence-Extinction Effects of Nickel and Cobalt on Zinc Sulphide.—J. Saddy & N. Arpiarian. (*C. R. Acad. Sci., Paris*, 31st May 1950, Vol. 230, No. 22, pp. 1948–1950.)

537.228.1 : 621.39 2525

Piezoelectric Elements in Telecommunications Technique.—J. J. Vormer. (*Tijdschr. ned. Radiogenoot.*, May 1950, Vol. 15, No. 3, pp. 93–127. In Dutch, with English summary.) Review of the physical and electrical properties of crystals of different cuts commonly used, with a tabular summary.

537.533.8 2526

Secondary-Electron Emission from Metal Mixtures.—H. Salow. (*Ann. Phys., Lpz.*, 16th Jan. 1950, Vol. 5,

Nos. 6/8, pp. 417–428.) Mixtures produced by simultaneous evaporation of either Ag or Cu and either Mg, Al or Be were found to have secondary-emission properties similar to those of alloys of the two components formed by melting. After a forming process in the presence of small quantities of O_2, secondary-emission factors of about 10 were obtained with 500-V primary electrons. The Cu/Mg metal mixture is easy to form, electrically and thermally stable, insensitive to dry CO_2-free gases, and very suitable for coating secondary-emission cathodes.

538.221 2527

The Magnetic Properties of Stainless Steels.—W. A. Stein. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1534–1537.) A comprehensive account of the magnetic properties of five stainless steels. Steel may contain up to 3% Ni without serious detrimental effect on its magnetic properties; the inclusion of over 8% Ni renders the steel nonmagnetic.

538.221 2528

Magnetic Properties of Ferrites.—C. Guillaud. (*J. Rech. Centre nat. Rech. sci.*, 1950, No. 12, pp. 113–122.) Experimental study and discussion of the saturation magnetization of simple and mixed ferrites. See also 1169 and 1171 of May (Néel).

538.221 2529

Properties of Single Crystals of Nickel Ferrite.—J. K. Galt, B. T. Matthias & J. P. Remeika. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 214.) Summary of American Physical Society paper.

538.221 2530

Relation between the Crystalline Structure and the Magnetic Properties of Mixed Ferrites of Nickel and Zinc.—M. Sage & C. Guillaud. (*C. R. Acad. Sci., Paris*, 15th May 1950, Vol. 230, No. 20, pp. 1751–1753.)

538.221 2531

Thermal Variation of the Spontaneous Magnetization of Ferrites of Nickel, Cobalt, Iron and Manganese.—R. Pauthenet. (*C. R. Acad. Sci., Paris*, 22nd May 1950, Vol. 230, No. 21, pp. 1842–1843.)

538.221 2532

A New Series of Ferromagnetic Substances : Ferrites of Rare Earths.—H. Forestier & G. Guiot-Guillain. (*C. R. Acad. Sci., Paris*, 22nd May 1950, Vol. 230, No. 21, pp. 1844–1845.)

538.221 : 538.65 : 536.413 2533

Length Anomaly in Ferrites.—L. Weil. (*C. R. Acad. Sci., Paris*, 10th July 1950, Vol. 231, No. 2, pp. 122–124.) Experimental study of the expansion coefficients of magnetized ferrites when slowly heated and then cooled.

538.221 : 538.653.11 2534

Effect of Tension on Magnetic Properties in Iron-Cobalt.—H. H. Plotkin & J. E. Goldman. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 215.) Summary of American Physical Society paper.

539.23 : 537.311.31 2535

On the Law of Variation of the Electrical Resistance of Very Thin Deposited Metal Films as a Function of the Applied Potential.—B. Vodar & N. Mostovetch. (*C. R. Acad. Sci. Paris*, 5th June 1950, Vol. 230, No. 23, pp. 2008–2010.) Previous experimental results (1701 of July) indicate that log (R_v/R_0) is a linear function of the applied potential except at very low potentials, R_v being the resistance at potential V. The change in conductivity is attributed to the lowering of the potential barrier between adjacent particles of the layer by the applied field. This effect is discussed in relation to a formula established by Schottky for the case of thermionic emission.

539.23 : 546.57 : 621.314.6 2536

On Certain Detector Properties of Thin Silver Films.—A. Blanc-Lapierre & M. Perrot. (*C. R. Acad. Sci., Paris*, 15th May 1950, Vol. 230, No. 20, pp. 1749–1751.) Measurements were made of the variation of current with applied direct and alternating voltages and with frequency. Appreciable detection effects were observed when the total power dissipated in the film was $> 1\ \mu W$. See also 2242 above.

539.23 : 546.81 2537

The Structure of Lead Sulfide Films.—J. Doughty, K. Lark-Horovitz, L. M. Roth & B. Shapiro. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 203.) Summary of American Physical Society paper. Investigation of films of PbS, PbSe and PbTe by X rays, electron diffraction and electron microscope.

539.23 : 546.81 : 535.215 2538

Temperature Variation of Properties of Photo-Sensitive Lead Sulfide Films.—R. H. McFee. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 203.) Summary of American Physical Society paper. Measurements made of dark current, photo-current and noise as functions of temperature between 90°K and 300°K.

546.841-3 : 537.311.3 2539

Electrical Resistance of Thoria.—W. E. Danforth & F. H. Morgan. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 142–144.) Measurements were made in vacuo at temperatures up to 2 073°K. On activation, values of 1 Ω-cm at 1 900° and 10 Ω-cm at 1 000° were obtained. Activation energies determined from pulse measurements were between 3.2 V and 0.58 V. The density of impurity centres was calculated as 10^{18} cm^3 and was found independent of the degree of activation by current. This result does not agree with the hypothesis of the electrolytic origin of impurity centres.

546.92 : 537.323 2540

Effect of Heat Treatment on the Electrical Properties of Platinum.—R. J. Corruccini. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 202.) Summary of American Physical Society paper.

620.197 : 679.5 2541

Casting-Resin Techniques.—J. Bayha. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 100–101.) Practical details are given about the materials and methods of preparation and use of N.B.S. casting resin.

621.314.632 2542

Metallographic Study of Germanium Point-Contact Rectifiers.—M. H. Dawson & B. H. Alexander. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 217.) Summary of American Physical Society paper.

621.315.592† + 537.311.3 2543

Electrical Conductivity.—R. Roulaud. (*Rev. gén. Élect.*, May 1950, Vol. 59, No. 5, pp. 211–225.) In part 1 different theories which have been proposed to account for the conductivity of solid bodies are discussed, particularly the contributions made by the quantum theory and wave mechanics. The classification of conductors according to electron activity is outlined and the potential barrier is discussed with reference to thermionic emission and the Schottky effect. Part 2 deals with semiconductors and discusses the effect of impurities on resistivity and

also their physical characteristics and rectifying properties. Part 3 reviews the properties of Ge, particularly those made use of in the transistor.

621.315.592† 2544

Electrical Properties of Semiconductors with Macroscopic Discontinuities.—J. C. M. Brentano & D. H. Davis. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 216.) Summary of American Physical Society paper.

621.315.592† : 546.28 2545

The Transition from Insulating to Metallic Behavior in Semiconducting Silicon.—G. W. Castellan & F. Seitz. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 216.) Summary of American Physical Society paper.

621.315.61.011.5 : 577.3 2546

The Determination of the Dielectric and Magnetic Properties of Inhomogeneous Dielectrics, particularly Biological Substances, in the Decimetre-Wave Region.—H. Schwan. (*Ann. Phys., Lpz.*, 16th Jan. 1950, Vol. 5, Nos. 6/8, pp. 253–310.) In three parts, dealing with (*a*) theory of resonance methods of determining complex resistance, (*b*) effect of the support at the end of the Lecher line used in such methods, (*c*) practical methods and appropriate formulae for determining the required constants of the materials tested.

621.315.61.011.5 : 621.317.3.029.63 2547

Decimetre-Wave Measurements of Temperature-Dependent Dielectric Properties of Insulating Materials.—Kreft. (*See* 2559.)

621.315.612.4.011.5 2548

The Ferroelectric Properties of Certain Titanates and Zirconates of Bivalent Metals having Perovskite Structure.—G. A. Smolenski. (*Zh. tekh. Fiz.*, Feb. 1950, Vol. 20, No. 2, pp. 137–148. In Russian.) An experimental as well as a theoretical investigation which shows that $CdTiO_3$, $PbTiO_3$, $PbZrO_3$, and the solid solutions $(Ca,Pb)TiO_3$ and $(Sr,Pb)TiO_3$ possess ferroelectric properties.

621.318.2 : 621.3.016.35 2459

Stabilized Permanent Magnets.—P. P. Cioffi. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1540–1543.) Permanent magnets are stabilized against forces tending to demagnetize them, by partial demagnetization. After stabilization the magnet operates on a secondary demagnetization curve. The derivation of this curve and its applications to magnet design problems are discussed.

621.396.822 : 539.23 : 621.315.616.9 2550

Random Noise in Dielectric Materials.—R. F. Boyer. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 469–477.) An account is given of observations on fluctuating currents resulting from the application of direct-voltage gradients of 10–300 V/mil to thin films of polar dielectrics containing moisture. The fluctuations have frequencies of 60–1 000 c/s and last for some minutes, even persisting for a few seconds after removal of the voltage; after dying out they can usually be restored by reversing the voltage. The corresponding noise level is about 1 000 times higher than that of the circuit noise. The noise is the greater the more polar the polymer and the higher the moisture content of the material. Groups of ions rather than single ions are believed to act as the random charge carriers.

669.15 : 538.652 2551

Magnetostriction in Magnetic Alloys with Preferred Crystal Orientation.—J. E. Goldman. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 215.) Summary of American Physical Society paper.

MATHEMATICS

517.392 2552

Numerical Evaluation of Integrals of the Form $I = \int_{x_1}^{x_2} f(x)e^{i\phi(x)}\,dx$ and the Tabulation of the Function $Gi(z) = (1/\pi)\int_0^\infty \sin(uz + \frac{1}{3}u^3)\,du$.—R. S. Scorer. (*Quart. J. Mech. appl. Math.*, March 1950, Vol. 3, Part 1, pp. 107–112.)

517.564 2553

On the Fourier and Mellin Transforms of Inverse Bessel Functions.—P. Barrucand. (*C. R. Acad. Sci., Paris*, 10th July 1950, Vol. 231, No. 2, pp. 102–104.) The transforms are applied to derive a formula by means of which many integrals can be developed in the form of series.

517.942 : 621.3.09 2554

The B.W.K. Approximation and Hill's Equation : Part 2.—L. Brillouin. (*Quart. appl. Math.*, Jan. 1950, Vol. 7, No. 4, pp. 363–380.) The B.W.K. procedure, developed in connection with wave mechanics, is shown capable of yielding a good approximate solution for problems in many other fields, including the propagation of e.m. waves along a transmission line whose properties vary from point to point. The validity of various approximations is examined.

517.942.82 : 517.522 2555

The Laplace Transformation and Summation Formulae.—P. Barrucand. (*C. R. Acad. Sci., Paris*, 3rd July 1950, Vol. 231, No. 1, pp. 20–22.) The Poisson, Hardy and other summation formulae are derived by use of the Laplace transformation.

517.942.932 2556

Notes on the Solution of the Equation $y'' - xy = f(x)$.—J. C. P. Miller & Z. Mursi. (*Quart. J. Mech. appl. Math.*, March 1950, Vol. 3, Part 1, pp. 113–118.)

681.142 2557

A Differential Analyzer for the Schrödinger Equation.—R. L. Garwin. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 411–416.) A simple and rapid analyser is discussed having an accuracy within about 0.5%. Possible extensions of its application are mentioned.

681.142 : 621.389 2558

A Fast Multiplying Circuit.—B. Chance, J. Busser & F. C. Williams. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 244.) Summary of American Physical Society paper. A development on the principle of the 'quarter-square' multiplication method. A single parabolic characteristic is used to square the amplitudes of alternate half-cycles of an 82-kc/s square wave which represent respectively the sum and difference of the two input voltages A and B. The difference of the squares gives the desired product $4AB$. The circuit gives the product of the inputs every 12 μs to within 1%.

MEASUREMENTS AND TEST GEAR

621.317.3.029.63 : 621.315.61.011.5 2559

Decimetre-Wave Measurements of Temperature-Dependent Dielectric Properties of Insulating Materials.—W. Kreft. (*Fernmeldetech. Z.*, June 1950, Vol. 3, No. 6, pp. 203–211.) A resonance method is described for measuring loss angle and permittivity, using two tubular concentric lines short-circuited at one end and capacitively coupled. One line, with a coupled current-meter, serves as indicator of the changes in the other line when a test sample is inserted which completely fills a certain length of the space between inner and outer conductor. Measurements in the wavelength range 10–75 cm were

made on various insulating materials at temperatures from 20° to 80°C. Results are given graphically and show that in general the loss angle increases very considerably with temperature, but the permittivity only slightly.

621.317.31 **2560**

Measurement of Current Intensity with an Ammeter of Apparent Resistance Zero.—M. Matschinski. (*C. R. Acad. Sci., Paris*, 31st May 1950, Vol. 230, No. 22, pp. 1937–1939.) The principle is analogous to that of the potentiometer method of voltage measurement. An auxiliary voltage source and variable resistor in series are connected across the ammeter and adjusted so as to compensate for the voltage drop due to the resistance of the ammeter. Applications of the method in the measurement of very weak currents are indicated.

621.317.32 **2561**

Negative-Feedback D.C. Amplifier with Grid-Controlled Valve Converter.—W. Geyger. (*Arch. tech. Messen*, May 1950, No. 172, p. T57.) The magnetic amplifier of the instrument described in 1450 of June is replaced by a differential double-triode circuit which acts as an anode-modulated converter. Voltage range becomes approximately 0.1–1 V with input resistance 1–100 MΩ.

621.317.332 **2562**

Resistance Measurement at High Frequencies by means of Lossless Quadripoles.—A. Egger & H. H. Meinke. (*Funk u. Ton*, May 1950, Vol. 4, No. 5, pp. 233–238.) Two equal, lossless and symmetrical 4-terminal networks are connected in series and terminated with the resistor R_1 to be measured. Measurements are made of the voltages across both ends of the whole network and that across the junction points. From these voltages and the known characteristic impedances and phase constants of the networks, R_1 may be determined. The method is suitable for the measurement of resistors of 20–300 Ω in the frequency range 30–100 Mc/s, but its applications are not restricted to this range.

621.317.335.3† + 621.317.374 **2563**

Measurement of the Specific Inductive Capacity and Loss Angle of Dielectrics between 50 kc/s and 100 Mc/s.—J. Jourdan. (*Onde élect.*, June 1950, Vol. 30, No. 279, pp. 285–292.) Description of a Marconi high-precision instrument, using the reactance-variation method, for industrial use. A Hartley oscillator is loosely coupled to the measurement circuit, which comprises a coupling inductor and two capacitors C_1 and C_2 in parallel across it. The dielectric material is placed between the plates of C_1, which has a micrometer adjustment; C_2 is tuned for resonance, as indicated on the 50-cm scale of a mirror galvanometer in the circuit of a square-law valve voltmeter; C_2 is then adjusted to give equal deflections on either side of resonance; the procedure is repeated without the dielectric. Loss angle and dielectric constant (and also resistance and capacitance) may be simply calculated from the formulae given. The theory of the method of measurement and accuracy of the instrument are discussed.

621.317.335.3.029.64† **2564**

Recording Microwave Refractometer.—(*Electronics*, July 1950, Vol. 23, No. 7, pp. 120, 122.) The difference in resonance frequency produced by introducing a sample of a substance under test into one of two otherwise identical cavity resonators is a measure of the dielectric constant of the sample. The equipment described, which was developed at the National Bureau of Standards, is sensitive to Q changes in the test cavity, hence its use is restricted to testing samples of low-loss materials. Possible application to the measurement of atmospheric refractive index at frequencies above 30 Mc/s is considered.

621.317.335.3.029.64† : 546.217 **2565**

Apparatus for Recording Fluctuations in the Refractive Index of the Atmosphere at 3.2 Centimeters Wave-Length.—C. M. Crain. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 456–457.) A modified version of apparatus previously used for measuring dielectric constants of gases. Two microwave oscillators have their frequencies controlled respectively by two invar cavity resonators, one of which is sealed off while the other has air drawn through it. By appropriate circuit arrangements, changes in the resonance frequency of this second cavity, due to fluctuations in the dielectric constant of the air, produce proportional deflections in a recording milliammeter.

621.317.36 : 621.396.611.21.001.4 **2566**

Checking Crystals.—P. O. Farnham. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 150–154.) The method and apparatus described are for crystals whose fundamental frequencies lie between 6 and 13 Mc/s. Modifications may be made to suit other applications.

621.317.7 : 621.392.26† **2567**

An Automatic Standing-Wave Indicator.—P. J. Allen. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1299–1302.) The probe of a conventional standing-wave indicator is moved over a distance exceeding one wavelength (3 cm) by a reciprocating device operated by a 100-r.p.m. motor. The output from the probe is amplified and applied to the vertical-deflection plates of a c.r.o. A voltage derived from a potentiometer attached to the probe carrier is simultaneously applied to the horizontal-deflection plates to give a deflection corresponding to the position of the probe, so that the waveform is displayed on the long-persistence screen. A graticule on the face of the c.r. tube permits the s.w.r. to be read directly. A cursor is provided for measuring the position of the standing-wave pattern.

621.317.7.029.62 **2568**

V.H.F. Testing and Measuring Equipment.—(*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 349–350.) A brief review of British v.h.f. electronic equipment, with technical details supplied by the manufacturers, who will give further details on request.

621.317.7.029.64 **2569**

Measurement Apparatus for Ultra-High Frequencies.—M. Bouix. (*Ann. Télécommun.*, June 1950, Vol. 5, No. 6, pp. 210–218.) Descriptions and illustrations of cavity wavemeters, slotted-line and coaxial-line sections, attenuators and matched terminations for waveguides, power meters, etc., developed in the Centre National d'Études des Télécommunications for measurements at wavelengths of about 3 cm and 10 cm.

621.317.725 **2570**

The Diotron — An Aid to R.M.S. Instrumentation.—R. D. Campbell. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 93–95.) A circuit is described comprising basically a temperature-limited diode and a d.c. amplifier connected in a feedback arrangement. It can be used as a voltmeter giving true r.m.s. readings. The voltage to be measured is applied to the diode filament terminals together with the d.c. heating voltage, the effect of feedback then being to maintain the filament heating power constant. A linear power scale is obtained for small inputs. Details are given of an instrument covering the frequency range 40 c/s–10 Mc/s and having a response time of 15 ms for frequencies above 1 kc/s; full-scale

deflection on the highest voltage range corresponds to 10 W across a 600-Ω load. Possible applications to computing circuits are outlined.

621.317.725 : 621.3.018.78† 2571

Distortion-Measurement Apparatus.—H. Boucke & H. Lennartz. (*Funk u. Ton*, May 1950, Vol. 4, No. 5, pp. 217–225.) Descriptions are given of (*a*) a simple instrument for harmonic measurement for input frequencies of 10, 20, 40, 160 kc/s; (*b*) an improved instrument for the same frequencies; (*c*) a distortion meter for 800 c/s. Circuits are shown; selective feedback and multiple harmonic filters are used. Harmonic voltages down to 0.5% of that of the fundamental can be measured with negligible error.

621.317.74 : 621.315.212 2572

Test Set for Impedance/Frequency Measurement on Coaxial Cables.—A. F. Boff. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 123–137.) Determination of the characteristic impedance, attenuation constant, phase constant, and velocity ratio of long lengths of coaxial cable is discussed. By avoiding frequency-dependent parameters in the measuring circuits, precise measurements may be made with a rapidity impossible with previous methods. A description is given of a portable test set covering the range 5–30 Mc/s.

621.317.757 2573

Simple Wave Analyser.—D. M. Tombs. (*Wireless Engr*, July 1950, Vol. 27, No. 322, pp. 197–200.) The selective property of a simple tuned circuit is used to isolate a particular frequency existing in a complex wave, the isolated harmonic and the wave to be analysed being both displayed on a double-beam c.r.o. The Q value of the tuned circuit governs the amplitude of the selected harmonic component and is adjusted over a wide range by means of a negative-resistance element.

The ratio of two harmonic amplitudes may be found by adjusting the Q values to make the magnified voltages the same for both in succession. The ratio is then given by a simple relation involving the frequency of the harmonics and the incremental adjustments of the tuning capacitor to obtain the half-power points, both these quantities being easily measured.

621.317.772 2574

High-Frequency Phase Measurement with Direct Indication: Part 1 — With a Cathode-Ray Tube as Indicator.—A. Ruhrmann. (*Arch. tech. Messen*, May 1950, No. 172, pp. T52–T53.)

621.317.799† : [621.396.813 + 621.396.822 2575

A Set for Noise and Distortion Tests on Carrier and Broadcast Systems.—A. F. Boff. (*Marconi Rev.*, 3rd quarter 1950, Vol. 13, No. 98, pp. 110–118.) The use of two simultaneous test tones enables distortion measurements to be made at frequencies up to the limit of the pass band and overcomes the limitations of conventional harmonic testing methods. Description and circuit and performance details are given of a compact test unit suitable for noise and distortion measurements on v.h.f. links.

621.385.012 : 621.317.79 2576

The Application of Direct-Current Resonant-Line-Type Pulsers to the Measurement of Vacuum-Tube Static Characteristics.—J. Leferson. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 668–670.) A method is described for obtaining the static characteristics of a valve in the positive-grid region by applying to the grid 4-μs pulses obtained from a conventional line-type pulse generator using a resonance method of charging. Grid and anode currents are observed on a synchroscope by means of voltages developed across noninductive resistors.

621.392.3 : 621.316.849 : 621.396.67.029.62 2577

High-Load H.F. Resistors of the Transmission-Line Type with Uniform Damping.—A. Kraus. (*Fernmeldetech. Z.*, May 1950, Vol. 3, No. 5, pp. 157–160.) Expressions are derived for the dimensions of a 60-Ω air-cooled dummy aerial in which a length of resistance wire is wound spirally on a grooved metal cylinder which constitutes the low-loss return line. Three such units illustrated are for use in the 30–200-Mc/s band for powers of 250 W, 1 kW and 10 kW; the last is cooled by air blast. Resistance is within 10% of 60 Ω over the whole frequency range.

621.396.615 : 621.316.726.078.3 2578

A Method of Locking Oscillators in Integral and Non-Integral Frequency Ratios.—E. A. G. Shaw. (*Brit. J. appl. Phys.*, June 1950, Vol. 1, No. 6, pp. 154–157.) The output voltages of the two a.f. oscillators to be locked are applied to a nonlinear mixer. A selected beat provides a suitable correction voltage to operate a reactance valve controlling the frequency of one oscillator. A practical circuit is described, giving locking with a 1 000-c/s signal over quite a large range of frequency ratios. Further developments are discussed. The method appears to be applicable to any frequencies.

621.396.615.17 2579

Various Applications of the Square-Wave Generator.—R. de L. Ortueta & J. M. H. Botas. (*Rev. Telecomunicación, Madrid*, Sept. 1949, Vol. 5, No. 17, pp. 40–52.)

621.396.615.17 : 621.392.018.424.001.4 2580

An Impulse-Generator/Electronic-Switch for Visual Testing of Wide-Band Networks.—T. R. Finch. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 657–661.) The instrument may be used to test any network that can be arranged to store a d.c. charge, the discharge characteristics produced by the network under test and by a reference network being simultaneously displayed for comparison. Representative applications are illustrated with the aid of c.r.o. traces and the circuit functions are described in detail.

621.396.616.029.64.001.4 2581

Kilomegacycle Buzzer Test Oscillator.—G. L. Davies, C. B. Pear, Jr, & P. E. P. White. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 96–99.) Voltage pulses with repetition frequency 800/sec derived from a battery-driven buzzer are applied to a cavity resonator tunable in the range 3–11 kMc/s. Outputs up to 200 μV across a 50-Ω load are obtained by adjustment of a simple piston attenuator.

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

534.321.9 : 061.3 2582

International Convention on Ultrasonics.—Bradfield. (*See* 2397.)

534.321.9 : 542.952.6 2583

Emulsion Polymerization with Ultrasonic Vibration.—A. S. Ostroski & R. B. Stambaugh. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 478–482.) Magnetostriction and piezoelectric oscillators, operating at 15 kc/s and 500 kc/s respectively, were used to study the effect of ultrasonic vibrations on the formation of such products as polystyrene and synthetic rubber. Above the threshold intensity required to produce cavitation, the time taken to reach a given yield of polymer is approximately inversely proportional to the power used.

534.415 : 621.396.915.141.2 2584

Stroboscopic Mapping of Time-Variable Fields.—L. Marton & D. L. Reverdin. (*J. appl. Phys.*, June 1950, Vol. 21, No. 6, pp. 617–618.) During investigations of the static field of a cut-off magnetron it was found that

the space-charge field was completely masked by the magnetic field due to the filament-heating current. To avoid this a half-wave rectifier was used to feed the filament and observation of the space-charge distribution was restricted to the half-cycle when no heating current was flowing. Pulse operation of the electron beam used for observation of the space charge was effected by square-wave modulation of the electron-gun bias voltage. The stroboscopic method is applicable in principle to the observation of recurrent, time-variable fields up to very high frequencies, a practical upper frequency limit being estimated at about 300 Mc/s.

621.57 : 621.318 2585

The Magnetic-Fluid Clutch.—J. Rabinow. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1308–1315.) A detailed discussion of principles and applications. See also 969 of April and back references.

621.316.86 : 536.581 2586

Thermistor Thermostats.—A. H. Taylor. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 154–159.) Two simple low-cost circuits suitable for controlling refrigerators and using Western Electric thermistors Type V-514 are described.

621.318.572 : 621.387.422† 2587

High-Speed Electronic Scaler.—W. M. Sessler & A. V. Masket. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, p. 494.) Ge diodes are used in a circuit developed from one described in Vol. 19 of the M.I.T. Radiation Laboratory series (2006 of 1949).

621.38.001.8 : 616-07 2588

Electronic Instruments in Diagnostic Medicine.—S. N. Pocock : W. Grey Walter: H. A. Hughes. (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 355–356.) Comments on 1207 of May (Hughes) and author's replies.

621.384.6 2589

200-kV Accelerator with Gas-Recovery System.—E. Almqvist, K. W. Allen, J. T. Dewan, T. P. Pepper & J. H. Sanders. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 209.) Summary of American Physical Society paper.

621.384.6 2590

Optimum Parameters for Particle Acceleration by TM_{010} Cylindrical Cavities.—B. L. Miller. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 209.) Summary of American Physical Society paper.

621.384.6 2591

Production of High-Current Electron Pulses by a Resonant-Cavity Accelerator.—G. W. Clark & L. B. Snoddy. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 232.) Summary of American Physical Society paper. Pulses of duration $<10^{-7}$ sec with electron energies >40 keV are obtained by use of a doubly reentrant cylindrical cavity operating at 400 Mc/s in conjunction with a pulsed electron source.

621.384.6 2592

Theory of the Radial Oscillations of the Electrons in an Electron Accelerator.—H. Jahn & H. Kopfermann. (*Ann. Phys., Lpz.*, 19th Sept. 1949, Vol. 6, pp. 305–320.) Approximate formulae for the oscillation amplitude of the electrons about their instantaneous orbits, and for the damping of the oscillations, are derived and applied to the field of the 6-MeV electron accelerator of the Siemens-Reiniger Werke.

621.384.611.1† 2593

An 80-MeV Model of a 300-MeV Betatron.—D. W. Kerst, G. D. Adams, H. W. Koch & C. S. Robinson. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 462–480.)

621.384.611.1† 2594

Performance of 300-MeV Betatron.—G. D. Adams, D. W. Kerst & C. S. Robinson. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 208.) Summary of American Physical Society paper.

621.384.611.2† 2595

Operation of the M.I.T. 350-MeV Electron Synchrotron.—I. A. Getting, J. S. Clark, J. E. Thomas, Jr, I. G. Swope & M. L. Sands. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 208.) Summary of American Physical Society paper.

621.384.611.2† 2596

Electron Injection Gun for the M.I.T. 350-MeV Synchrotron.—O. Stone. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 209.) Summary of American Physical Society paper.

621.384.611.2† 2597

Design of Magnet Ends and Straight Sections for a Racetrack Synchrotron.—G. B. Beard, J. L. Levy, W. A. Nierenberg & R. W. Pidd. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 209.) Summary of American Physical Society paper.

621.384.611.2† 2598

Synchrotron Radiofrequency System.—M. H. Dazey, J. V. Franck, A. C. Helmholz, C. S. Nunan & J. M. Peterson. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 436–439.) Description of the r.f. system of the Berkeley synchrotron.

621.384.611.2† 2599

Theory of the Capture Process in a Betatron-Injected Synchrotron.—D. C. de Packh & M. Birnbaum. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 451–456.)

621.384.612.1† 2600

A Focusing Device for the External 350-MeV Proton Beam of the 184-Inch Cyclotron at Berkeley.—W. K. H. Panofsky & W. R. Baker. (*Rev. sci. Instrum.*, May 1950, Vol. 21, No. 5, pp. 445–447.)

621.385.833+535.822 2601

Electrons *vs* Photons: A Comparison of Microscopes.—L. Marton. (*J. opt. Soc. Amer.*, May 1950, Vol. 40, No. 5, pp. 269–274.) Comparison of electron and light microscopes, with discussion of the discrepancy between the theoretical resolving power of the electron microscope and the values obtained in practice.

621.387.4† : 549.211 2602

Some Phenomena in Diamond Gamma-Ray Counters.—E. Pearlstein & R. B. Sutton. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 217.) Summary of American Physical Society paper.

621.387.424† 2603

Geiger Counter for Lectures.—R. L. Ives. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 105–107.) Circuit details are given of a portable instrument capable of delivering 50 W a.f. output at 1 000 counts/sec, and provided with strobotron flasher and thyratron-driven rate meter as auxiliary indicators.

778.37 : 537.523.4 2604

A Barium Titanate Coaxial Cable for the Production of a Short-Duration Spark.—J. A. Fitzpatrick & W. J. Thaler. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 231.) Summary of American Physical Society paper. A coaxial capacitor of overall length 16.5 cm, with $BaTiO_3$ dielectric of permittivity 1575 giving a capacitance of 0.02 μF, was used in spark photography of ultrasonic waves in water at frequencies up to 7 Mc/s.

621.387.4.9 2605

Ionization Chambers and Counters, Experimental Techniques. [Book Review]—B. B. Rossi & H. H. Staub. Publishers: McGraw-Hill Book Co., New York, 1st edn 1949, 243 pp., 19s. 6d. (in Great Britain). (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 352–353.)

PROPAGATION OF WAVES

061.3 : [621.396.11+55 2606

Summary of Proceedings of Australian National Committee of Radio Science, U.R.S.I., Sydney, January 16-20, 1950.—(*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 191–210.) Summaries are given of 33 papers presented at the conference.

538.566+[537.226.2 : 546.217 2607

The Velocity of Electromagnetic Waves and the Dielectric Constant of Dry Air.—Hughes. (*See* 2489.)

538.566 2608

Higher-Order Approximations in Ionospheric Wave-Propagation.—J. Feinstein. (*J. geophys. Res.*, June 1950, Vol. 55, No. 2, pp. 161–170.) The ionosphere, even when assumed homogeneous, can be considered as a linear medium for the propagation of e.m. waves only as a first approximation. Second-order terms give rise to harmonics, and to sum and difference frequencies when two independent waves traverse the same physical region. These new frequencies are, in general, of the nature of forced vibrations, except in the case where their propagation characteristics are those of a natural mode capable of existing in the region. A resonance effect then occurs, the new wave increasing its energy at the expense of the interacting waves, and assuming an independent existence. While these effects couple energy from the primary wave, they do not affect its propagation characteristics.

As a result of the degeneracy of the determinantal equation for the propagation constant, the introduction of any disturbing physical effects, such as a layer drift velocity, raises the degree of the equation, resulting not merely in changes in the values of the propagation constants of the usual modes, but, in addition, introducing new ones. For the usual disturbing effects encountered in the ionosphere, the energy content of these new modes is negligibly small.

538.566 : 537.562 2609

Electromagnetic Waves in Bounded Magneto-Ionic Media.—B. Lax. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 222.) Summary of American Physical Society paper. Discussion and theoretical study of h.f. waves in ionized gases in the presence of an external magnetic field, particularly the determination of the complex frequency when the value of the propagation vector is fixed or limited, as might be the case in a finite cavity resonator or waveguide.

621.396.11+535.222 2610

Can the Velocity of Propagation of Radio Waves be Measured by Shoran?—C. I. Aslakson. (*Trans. Amer. geophys. Union*, Aug. 1949, Vol. 30, No. 4, pp. 475–487.) An account is given of radar methods used to measure 47 lines of a shoran system of lengths ranging from 67 to 367 miles. Six of these lines could be compared with distances determined by first-order triangulation. Coordination of the shoran results with the geodetic measurements gave a mean value of 299 792.3 km/s for the velocity of propagation of radio waves, after making various corrections. See also 2010 of August (Essen).

621.396.11 : 551.510.535 2611

Ionosphere Observations at 50 kc/s.—Brown & Watts. (*See* 2506.)

621.396.11 : 551.57 2612

The Importance of Water Vapor in Microwave Propagation at Temperatures below Freezing.—D. G. Yerg. (*Bull. Amer. met. Soc.*, May 1950, Vol. 31, No. 5, pp. 175–177.) Calculations based on experimental results indicate that the vapour-pressure term in the refractive-index equation cannot be neglected for temperatures above −35°C. For temperatures between −35°C and −20°C the vapour-pressure gradient may be quite significant and at temperatures above −20°C it may be the dominant factor.

621.396.81 2613

Propagation of Waves of Frequencies from 2.5 to 35 Mc/s between Washington and Madrid.—(*Rev. Telecomunicación, Madrid*, Sept. 1949, Vol. 5, No. 17, pp. 2–18.) An account of N.B.S. prediction methods, and of an experimental investigation into quality of reception for these frequencies, with a view to obtaining data on which predictions might be based. Observations were made hourly from 0700 to 2200 for the period Dec. 1948 to March 1949. Graphs of receiver output power against time of day, and of m.u.f. and optimum working frequency against time of day, display the results for each fortnight of the period. These are discussed and compared with N.B.S. charts, and suggestions are made for extension of the WWV standard-frequency transmissions.

621.396.81 2614

'Probable Law' of Propagation of Short Waves for Ranges of 1300 km from Europe.—R. G. Sacasa. (*Rev. Telecomunicación, Madrid*, Sept. 1949, Vol. 5, No. 17, pp. 19–35.) Observations were made in 1945 and 1947–1949 of the times at which reception in Madrid of various s.w. signals from London commenced or ceased to be of practical value. From the results obtained a simple numerical relation is deduced between the optimum working frequency F Mc/s at sunrise (or sunset) and the optimum frequency f Mc/s at a time n hours later or earlier (n being respectively positive or negative). $f = F + 2n$, the sign depending on whether the interval is measured from sunrise or from sunset, for which the value of F is much higher than for sunrise. For E-W or W-E transmissions a different value of the factor of n is required. Graphs of the signal strength of transmissions from London around 1300 G.M.T. indicate some dependence on the length of day.

621.396.81 2615

Optimum Working Frequencies for Ranges from 0 to 2 500 km.—R. G. Sacasa. (*Rev. Telecomunicación, Madrid*, Sept. 1949, Vol. 5, No. 17, pp. 36–39.) An adaptation of a N.B.S. abac is reproduced and explained; from this either the m.u.f. or the optimum working frequency can easily be determined for any range up to 2 500 km.

621.396.81.029.63/.64 2616

A Microwave Propagation Test.—J. Z. Millar & L. A. Byam, Jr. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 619–626.) A description is given of a microwave propagation test which was conducted over a period of a year with simultaneous transmission on wavelengths of 16.2, 7.2, 4.7, and 3.1 cm over an unobstructed 42-mile overland path. Comparative charts depict variations in daily fading range, illustrate diurnal and seasonal characteristics of fading, and reveal the marked difference between winter and summer fading. Curves are presented showing relative field-strength distribution for both winter and summer periods, and also the distribution of hourly minima. These curves may be useful in considerations bearing on the continuity of service that may be expected for different wavelengths and times of day in winter or in summer.

621.396.812 2617

Effects of Radio Gyrointeraction and their Interpretation.—M. Cutolo. (*Nature, Lond.*, 15th July 1950, Vol. 166, No. 4211, pp. 98–100.) Experiments performed in Italy during June–July 1949 are described, using Taranto as the wanted station with Turin as the receiving station and Radio Florence II as the interfering station. The interfering carrier frequency was varied from 1 092 kc/s to 1 333.33 kc/s to pass through the gyrofrequency, estimated to be 1 190 kc/s at 90 km above the earth. The results obtained were in agreement with the theoretical double-humped curve given by Bailey (9 of 1939) and are used to explain earlier results (1476, 1477 and 1767 of 1949). Minimum interaction was obtained on a frequency corresponding to the local gyrofrequency at Montefalco, midway between transmitter and receiver, the presumed reflection point of the wanted wave. Solar activity was also observed to influence gyrointeraction, the phenomenon being weak or absent for a Wolf's number up to 100.

RECEPTION

621.396.621 2618

Low-Noise F.M. Front End.—J. Marshall. (*Radio-Electronics*, June 1950, Vol. 21, No. 9, pp. 58 . . 63.) Construction details are given of a ganged, low-noise r.f. amplifier and mixer circuit which converts signals in the f.m. band to an i.f. of 10.7 Mc/s. A high-gain i.f. amplifier for use with this equipment will be described in a subsequent article.

621.396.621 : 621.396.822 2619

Note on Low-Noise-Figure Input Circuits.—A. C. Hudson. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 684–685.) Comment on 1504 of June (Lebenbaum).

621.396.823 2620

Measurement of Interference from Radio-Frequency Heating Equipment.—G. H. Brown. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1102–1106.) Discussion of m.f. and v.h.f. radiation from dielectric- and induction-heating equipment, and a comparison of the theoretical r.f. field strengths with measurements.

STATIONS AND COMMUNICATIONS SYSTEMS

621.394.3+621.396.3 2621

Military Teletypewriter Systems of World War II.—F. J. Singer. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 1398–1408.) An illustrated review of equipment developed by the Bell Telephone Laboratories for line and radio links, with discussion and block diagrams of the various systems used.

621.395 : 06.053 2622

Fifteenth Plenary Assembly of the Comité Consultatif International Téléphonique, Paris, 1949.—P. E. Erikson. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 87–100.) See also 455 of February and 994 of April.

621.396.13 : 621.396.619.2 2623

The Single-Sideband System of Radio-Communication.—H. D. B. Kirby. (*Electronic Engng*, July 1950, Vol. 22, No. 269, pp. 259–263.) The advantages of the s.s.b. system over the normal d.s.b. method of operating a radio link are discussed and a short description is given of s.s.b. equipment in s.s. *Caronia*.

621.396.65.029.63 2624

Decimetre Waves in the German Telephone Service.—E. Dietrich & P. Barkow. (*Fernmeldetech. Z.*, May 1950, Vol. 3, No. 5, pp. 145–154.) Description of two multi-channel f.m. systems in use and brief discussion of optimum operating conditions.

621.396.73 : 623.396.61 2625

V.H.F. Equipment for Sound Broadcasting.—(*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, p. 309.) A pack-set transmitter-receiver has been designed for use by B.B.C. commentators at golf matches, race meetings, etc. It is carried on the commentator's back. The f.m. transmitter operates in the 90-Mc/s band and has an output of about 1 W, with a frequency response curve sensibly flat from 50 c/s to 6 kc/s. A 250-V HgO anode battery and accumulator filament battery are adequate for three hours continuous working. The 70-Mc/s receiver enables the commentator to receive information from the engineer at the control point, where a small a.m. transmitter is installed. The portable transmitter, complete with batteries, $\lambda/4$ whip aerial and harness, weighs 17 lb; the receiver brings the total weight to 26 lb.

621.396.931/.932 2626

The Metropolitan Police Radio Communication System.—E. C. Brown. (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 316–322.) A review of developments from 1923 onwards, with a description of the present R/T system which provides two-way communication between New Scotland Yard and some 200 vehicles, besides 13 launches of the River Thames Division. The present scheme uses two main frequency channels, but will eventually use four main and two subsidiary channels. A system of coaxial filters at the main station enables separate transmitters on different frequencies to feed into a common wide-band aerial. A similar system is used for the station receivers. Phase modulation is used and all transmitting equipment is crystal controlled. The output of the main-station transmitter is 250 W in the 95–100-Mc/s band, that of the mobile transmitters being 10 W in the 80–84-Mc/s band. The receivers are of the double-superheterodyne type. Further developments envisaged are the provision of R/T equipment for motor cycles, with selective calling arrangements, and the use of similar equipment for cars.

621.396.931/.932 2627

Multi-Station V.H.F. Schemes.—J. R. Brinkley. (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 323–325.) Many v.h.f. mobile-communication problems can be solved by the single-station method, but for large rural areas, estuaries, trunk roads and railways, multi-station systems have decided advantages, though they are necessarily more complex. A 2-station scheme using a.m. has been in use by the Hertfordshire county police since 1947 with complete reliability. Ten further multicarrier schemes have been installed in various counties in England, seven being 2-station and the rest 3-station schemes. A 3-station scheme is also in use by the Lanarkshire Fire Service. For estuary and coastal problems the G.P.O. authorities have decided to use multicarrier a.m. equipment.

621.396.931/.932 2628

Design Problems of V.H.F. Mobile Equipment.—L. W. D. Sharp. (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 331–337.) Operating requirements of v.h.f. mobile systems and equipment are outlined and transmitter and receiver design problems are discussed with particular reference to transmitter power, receiver sensitivity and the type of modulation adopted. Block diagrams illustrate the essential differences between f.m. and a.m. transmitters and receivers. Valves, components, power-supply units, and types of construction to make equipment suitable for use under the adverse conditions frequently met and to permit easy servicing are also discussed.

621.396.931/.932 2629

Planning V.H.F. Mobile Systems.—E. R. Burroughes. (*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 298–304.) See also 1248 of May.

621.396.931/.932 : 621.396.6 2630

V.H.F. [mobile] **Equipment.**—(*Electronic Engng*, Aug. 1950, Vol. 22, No. 270, pp. 340–348.) A review, with illustrations and technical details, of a wide range of British transmitting and receiving equipment available for v.h.f. mobile radio services. The information has been supplied by the manufacturers, who will give further details on request. Both a.m. and f.m. systems are included.

621.396.931 2631

Mobile Radio.—A. Bailey. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 923–931. Discussion, pp. 932–933.) An account of the development of mobile communication systems for police, taxicab and general telephone services from 1921 onwards, with details of the Bell System general mobile service for urban and highway use.

621.396.931 : 621.396.619.13 2632

Multi-Station V.H.F. Communication Systems using Frequency Modulation.—W. P. Cole & E. G. Hamer. (*J. Brit. Instn Radio Engrs*, July 1950, Vol. 10, No. 7, pp. 244–258.) Reasons for the use of multistation systems for mobile communications are discussed and previous tests with f.m. equipment are reviewed. Standard equipment for a single-station scheme is examined and from this the performance requirements for multistation equipment are derived. Suitable frequencies for the main carriers and for a control link are discussed and equipment used in a multistation scheme is described in detail. Distortion due to multipath transmission is analysed and practical tests of multistation systems in the London area and in Scotland are described. Future trends in development of such systems are indicated.

621.396.932 2633

New Marine V.H.F. Radio System.—(*Overseas Engr*, July 1950, Vol. 23, No. 273, pp. 449–450.) General description of the ship/shore telephony system for the port of Liverpool. Transmitters and receivers are crystal controlled and a.m. is used. Six channels are provided; the shore stations transmit on frequencies in the range 163.1–163.6 Mc/s, the frequencies for the mobile equipment being 4.5 Mc/s lower in each case. The weight of the portable sets, which are both rain- and water-proof, is < 20 lb. Good communication is obtained within a range of 25 miles.

SUBSIDIARY APPARATUS

621-526 2634

Note on the Maximum Accuracy of Perfectly Stable Servomechanisms.—G. Lehmann. (*Onde élect.*, June 1950, Vol. 30, No. 279, pp. 267–270.) If an unconditionally stable servomechanism includes an element which introduces a phase change not effectively zero, its accuracy at relatively low frequencies is necessarily limited. This limiting value is calculated for a simple case. Attention is drawn to the possible danger of exceeding this limit in a system only conditionally stable.

621.313.3 : 621.3.026.441† 2635

Flea-Power Industrial Synchronous Motors.—A. B. Poole. (*Elect. Mfg, N.Y.*, Jan. 1949, Vol. 43, No. 1, pp. 74–77, 172.) Operational principles, design features and output characteristics of three basic types of clock motor: the hysteresis, shaded-pole induction, and inductor types.

621.314.622 2636

Rectifiers with Mechanical Contacts.—A. Mongault. (*Rev. gén. Elect.*, May 1950, Vol. 59, No. 5, pp. 208–210.) Discussion of requirements for efficient commutation in a polyphase generator, i.e., minimum sparking and optimum inductance of the windings.

TELEVISION AND PHOTOTELEGRAPHY

621.397.5 2637

Distant Electric Vision.—J. D. McGee. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 596–608.) Reprint. See 761 of March.

621.397.5 2638

Television in Relief and in Colour.—Y. Delbord. (*Ann. Télécommun.*, June 1950, Vol. 5, No. 6, pp. 219–228.) Paper presented at the Television Congress in Milan, September 1949. Four methods are discussed and their advantages, disadvantages, and applicability to black-and-white, relief or colour television are tabulated. These are (*a*) fixed vertical-band scanning frame; (*b*) rotating disk; (*c*) multiple channel; (*d*) multiple image. The basic principles of the methods are described with regard to transmission and reception. For relief television, method (*d*) is regarded as affording the simplest satisfactory solution. For colour television a combination of the best features of (*b*), (*c*) and (*d*) is desirable.

621.397.5 2639

Kell Factor and Picture Definition in Television Transmissions with Constant Bandwidth.—E. Schwartz. (*Fernmeldetech. Z.*, June 1950, Vol. 3, No. 6, pp. 185–190.) Discussion of the optimum 'K-factor' (ratio of horizontal to vertical resolution) and comparison of different systems. See also 3942 of 1940 (Kell, Bedford & Fredendall).

621.397.5 2640

An Analysis of the Sampling Principles of the Dot-Sequential Color-Television System.—R.C.A. Laboratories Division. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 255–280.) A quantitative treatment of the influence of the width of the sampling pulse on colour crosstalk, the response of standard monochrome-television receivers and colour-television receivers to sinusoidal variations and to step functions, the way in which the method of 'mixed highs' combines with the sampling procedure to produce h.f. detail, and circuit methods of eliminating crosstalk.

621.397.5 : 535.88 : 532.62 2641

The Eidophor Method for Theater Television.—E. Labin. (*J. Soc. Mot. Pict. Televis. Engrs*, April 1950, Vol. 54, No. 4, pp. 393–406.) See also 3561 of 1949 (Thiemann).

621.397.5(083.74) 2642

Choice of Television Standards.—(*Wireless World*, July 1950, Vol. 56, No. 7, pp. 249–250.) Reasons are given for considering that the choice of the 405-line standard is fundamentally sound, both from an engineering and an economic viewpoint. When the capabilities of 405-line television have been fully exploited, any small improvement that might be obtained by increasing the number of lines will be offset by the difficulties which will be encountered in maintaining the larger bandwidth required and in ensuring that the degree of overall distortion does not exceed the more stringent limits of tolerance.

621.397.6 : 535.88 2643

Projection Television.—J. Haantjes & J. J. P. Valeton. (*Tijdschr. ned. Radiogenoot.*, July 1949, Vol. 14, No. 4, pp. 99–117.) Description of the MW6-2 c.r. tube, Schmidt-type optical system and h.v. supply unit. See also 2387 of 1948 (Rinia et al.).

621.397.6 : 621.396.97 **2644**

Ultra-High-Frequency Antenna and System for Television Transmission.—Fiet. (*See* 2425.)

621.397.6.001.8 **2645**

Industrial Television System.—R. W. Sanders. (*Elect. Commun.*, June 1950, Vol. 27, No. 2, pp. 101–111.) Detailed description of equipment which uses a new type of image-dissector tube with a translucent photocathode. See also *Electronics*, July 1950, Vol. 23, No. 7, pp. 88–92.

621.397.61 **2646**

A New Ultra-High-Frequency Television Transmitter.—Lappin & Bennett. (*See* 2659.)

621.397.61(47) **2647**

Television in the Soviet Union.—(*Fernmeldetech. Z.*, June 1950, Vol. 3, No. 6, p. 218.) Brief note of what is known of the two transmitters in service at Moscow and Leningrad. Two other stations are under construction, one in Kiev to serve South Russia, the other in Sverdlovsk to serve eastern Russia and the Ural region.

621.397.62 **2648**

General Description of Receivers for the Dot-Sequential Color-Television System which employ Direct-View Tri-Colour Kinescopes.—R.C.A. Laboratories Division & R.C.A. Victor Division. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 228–232.) See also 2363 above.

621.397.62 **2649**

Sync-Separator Analysis.—W. Heiser. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 108–111.) The response of a particular clipper circuit for separating synchronizing signals from the composite television signal is analysed. Formulae are derived for use in designing such circuits, and calculated results are compared with measured results for test signals.

621.397.62 : 621.396.615.16 **2650**

A Hard-Valve Time-Base.—Banthorpe. (*See* 2455.)

621.397.67 : [621.317.733 + 621.392.52 **2651**

Television Antenna Diplexers.—W. H. Sayer, Jr, & J. M. De Bell, Jr. (*Electronics*, July 1950, Vol. 23, No. 7, pp. 74–77.) Methods are described which enable two or more closely spaced r.f. signals (e.g. vision and sound carriers) to be transmitted from one aerial, with a minimum of interaction between signal sources. Impedance bridges or 'notch' filters formed of coaxial lines are used. Diplexers may also be used to add together the synchronized outputs of two generators so as to obtain high power; waveguide and coaxial-ring (rat-race) hybrids for this purpose are described. See also 1355 of June, No. 80.

621.397.81 **2652**

Midlands Television Area.—(*Wireless World*, July 1950, Vol. 56, No. 7, p. 266.) A map, based on a B.B.C. survey, showing approximate field-strength contours for the vision signals from the Sutton Coldfield transmitter.

621.397.82 **2653**

A Study of Cochannel and Adjacent-Channel Interference of Television Signals: Part 2 — Adjacent-Channel Studies.—R.C.A. Laboratories Division. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 287–295.) In the observer tests, colour signals characteristic of the field-sequential, line-sequential, and dot-sequential systems were included. A standard monochrome signal was paired with a monochrome signal and the colour signals in some of the tests. In all instances, the interfering sound signal was present. From the standpoint of allocation, no substantial difference in the tolerable ratios was found for the various combinations of colour and monochrome signals used. Part 1: 1798 of July.

621.397.828 : 621.396.61 **2654**

Tackling TVI at the Output End.—Tapson. (*See* 2661.)

621.397.828 : 621.396.677 **2655**

TV Antenna Phase Control.—G. N. Carmichael. (*Radio-Electronics*, June 1950, Vol. 21, No. 9, pp. 54, 56.) A method of reducing co-channel interference and increasing wanted signal strength in fringe areas. Two Yagi arrays are used, spaced to give a phase difference of about 90° for angles of incidence of the downcoming wave commonly found in fringe areas. The outputs from the two arrays are fed separately to a variable phase control, which partially cancels unwanted, and adds wanted signal voltages. Depending on the angle between the directions of the incoming signals, the combination can give a rejection ratio of 35–40 db, and a forward gain of 15 db, compared with a dipole.

621.397 **2656**

Facsimile. [Book Review]—C. R. Jones. Publishers: Murray Hill Books, New York, 1949, 422 pp., $6.00. (*J. Franklin Inst.*, March 1950, Vol. 249, No. 3, p. 255.) Apparently intended for those concerned with the use and maintenance of facsimile equipment rather than with its design.

TRANSMISSION

621.396.61 : 621.396.645 **2657**

Maximum Tank Voltage in Class-C Amplifiers.—Dwork. (*See* 2460.)

621.396.61 : 621.396.97 **2658**

A New 150-kW Transmitter for Standard-Band Broadcasting.—T. J. Boerner. (*Trans. Amer. Inst. elect. Engrs*, 1948, Vol. 67, Part II, pp. 943–951.) A detailed description of a 540–1 600-kc/s transmitter with high-level modulation. A class-B modulator is used for a.m. of the class-C final r.f. amplifier, thus permitting the highest overall efficiency with relative ease of adjustment.

621.397.61 **2659**

A New Ultra-High-Frequency Television Transmitter.—L. S. Lappin & J. R. Bennett. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 190–211.) Detailed description of the 1-kW Type-TTU-1A transmitter recently installed and now in operation at Bridgeport, Connecticut. The h.f. tripler and power amplifier are operated as grounded-cathode grounded-screen amplifiers, each using eight Type-4X150A valves mounted in a single cavity. A sectional diagram of the cavity is given. See also 1795 of July (Guy, Seibert & Smith).

621.397.67 : [621.317.733 + 621.392.52 **2660**

Television Antenna Diplexers.—Sayer & De Bell (*See* 2651.)

621.397.828 : 621.396.61 **2661**

Tackling TVI at the Output End.—M. E. Tapson. (*Short Wave Mag.*, June 1950, Vol. 8, No. 4, pp. 265–266.) Use of third-harmonic traps in the anode circuit of the power amplifier, link coupling to the aerial system, and a folded dipole adjusted for low feeder s.w.r., minimized interference from a 100-W 14-Mc/s amateur transmitter, so that television reception was practicable within about 20 yards.

VALVES AND THERMIONICS

537.533.8 **2662**

Secondary-Electron Emission from Metal Mixtures.—Salow. (*See* 2526.)

621.383.27† 2663

Calculation of the Elements of an Electron-Multiplier Tube and its Realization.—A. Lallemand. (*Le Vide*, May 1949, Vol. 4, No. 21, pp. 618–624.) Various factors relevant to the design of photoelectric multiplier tubes are discussed, including type of cathode, form and coating of multiplier surfaces, and arrangements for obtaining suitable electron trajectories. The multiplier grids finally adopted consisted of parallel narrow strips inclined at about 45° to the mean grid plane, a grid of fine wires maintained at the same potential as the multiplier being fixed a little in front of each multiplier. Tubes using this type of construction have been produced with 7, 12, 17 and 19 stages, the multiplication factors for 120-V operation ranging from 1 215 to 3.7×10^8.

621.383.27† 2664

Rise Times of Voltage Pulses from Photo-Multipliers.—O. Martinson, P. Isaacs, H. Brown & I. W. Ruderman. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 178.) Includes a brief description of a method of measuring short rise-times without the use of a high-speed oscillograph.

621.385.012 : 621.317.79 2665

The Application of Direct-Current Resonant-Line-Type Pulsers to the Measurement of Vacuum-Tube Static Characteristics.—Leferson. (*See* 2576.)

621.385.029.63/.64 + 621.396.615.142.2 2666

Recent Developments in Amplifying Valves for Centimetre Waves.—G. Goudet. (*Ann. Télécommun.*, Dec. 1948, Vol. 3, No. 12, pp. 445–455.) Limitations of klystron amplifiers are discussed and a description is given of the wide-band double-resonator klystron designed by engineers of the Laboratoire Central de Télécommunications. With anode voltage 8 kV, electron current 100 mA, the output is 12 W, power gain 40 and pass band 50 Mc/s, or 20 W under slightly different operating conditions, with gain 100 and pass band 25 Mc/s. A similar 2-stage valve (3 cavity resonators) has an output of 2 W, a power gain of 200 and pass band 20 Mc/s.

Travelling-wave valves are also considered briefly and a simplified theory of their operation, with derivation of design and performance formulae, is given in an appendix. See also 1294 of May.

621.385.032.216 2667

Pulsed Operation of Oxide Cathodes.—C. Biguenet. (*Le Vide*, July/Sept. 1949, Vol. 4, Nos. 22/23, pp. 661–668.) The theory of steady-state operation is reviewed briefly and a theory of pulsed operation is proposed which assumes that under the action of the electric field a displacement of Ba ions in the thickness of the oxide layer occurs. These positive charges create a very intense field near the surface of the metal support and tear electrons out of it. Some of these electrons neutralize the positive charges, the rest play an important part in the electron emission. The time necessary for the neutralization of the positive charges appears to be of the order of 5 μs, so that in pulsed operation the duration of application of the anode voltage should be less than this value. Experiments with the object of confirming the theory are described.

621.385.032.216 2668

Deterioration of Oxide-Coated Cathodes under Low Duty-Factor Operation.—J. F. Waymouth, Jr. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, p. 233.) Summary of American Physical Society paper. Investigation of the effect of emission-current duty-factor on cathode life.

621.385.032.216 : 621.3.011.2 2669

Electrical Conductivity of Oxide-Cathode Coatings.—D. A. Wright. (*Brit. J. appl. Phys.*, June 1950, Vol. 1, No. 6, pp. 150–153.) See 2078 of August.

621.385.1 : 621.396.822 2670

Current Fluctuations in D.C. Gas-Discharge Plasma.—P. Parzen & L. Goldstein. (*Phys. Rev.*, 1st July 1950, Vol. 79, No. 1, pp. 190–191.) Mathematical analysis deriving an expression for the effective noise power due to current fluctuations in a gas-discharge plasma in a rectangular waveguide transmitting in only its lowest mode. For ordinary gas valves used as microwave noise sources the contribution of the frequency-dependent term in the expression for noise power is small.

621.385.2/.5.029.62 2671

A Survey of V.H.F. Valve Developments.—(*Electronic Engng.* Aug. 1950, Vol. 22, No. 270, pp. 310–315.) The factors limiting the upper working frequencies of ordinary valves are discussed, together with the difficulties encountered in the development of v.h.f. valves; a survey is made of the various types at present available. A list of the characteristics of a selected range of disk-seal triodes is included.

621.385.3 : 621.315.592† : 546.815.221 2672

On the Frequency Response of PbS Transistors.—P. C. Banbury & K. H. Henisch. (*Proc. phys. Soc.*, 1st July 1950, Vol. 63, No. 367B, pp. 540–541.) The response of PbS transistors is found to be comparable with that of Ge transistors. The h.f. response can be extended somewhat by the use of higher collector voltages or by the application of a suitably oriented magnetic field. The variation produced by the magnetic field, though only small, shows by its sense that the charge carriers are electrons, as in the Ge *p*-type transistor. See also 2088 of August (Gebbie, Banbury & Hogarth), 2089 of August (Brown) and 2459 above.

621.385.3 : 621.315.592† : 621.396.645 2673

High-Frequency Operation of Transistors.—Brown. (*See* 2459.)

621.385.3.029.62 : 621.396.822 2674

On the Space-Charge Smoothing of Shot Fluctuations in Triode Systems Responding to Very High Frequencies.—I. A. Harris. (*J. Brit. Instn Radio Engrs*, July 1950, Vol. 10, No. 7, pp. 229–240.) Existing theoretical results are briefly reviewed and a simplified theory of space-charge smoothing of shot fluctuations in a diode, based on the Benham-Llewellyn theory, is discussed in some detail. This theory is then applied to cases in the v.h.f. range where electron transit times are appreciable, and it is concluded that the l.f. smoothing factor is not appreciably changed up to transit angles of about 1 radian. Application of the theory to the noise of grounded-grid triode circuits gives results in better agreement with experiment than those based on earlier theories. The effect on noise of applying a nonuniform field at the cathode of a triode is also considered.

621.385.38 2675

Studies of Thyratron Behavior: Part 1 — The Effect of Grid Resistance on the Recovery Time of Thyratrons.—L. Malter & E. O. Johnson. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 165–177.) Theoretical and practical investigations of the grid-voltage and current characteristics of a commercial thyratron, for different values of grid resistance and bias, during the period following the interruption of the discharge. During the recovery period electron current may flow to the grid if the voltage drop across the grid resistor due to positive-ion

current exceeds the bias voltage. The increase of recovery time with increasing value of grid resistance is due to the delayed return of the grid voltage to its bias value and not to a decreased rate of deionization, this rate being essentially independent of grid resistance and voltage. The recovery time is also dependent upon the instantaneous value of the actual grid voltage. See also 2676 below.

621.385.38 **2676**

Studies of Thyratron Behavior: Part 2 — A Study of the Effect of Grid Potential Variations during the Afterglow Period upon the Recovery Time of Thyratrons.—E. O. Johnson & L. Malter. (*RCA Rev.*, June 1950, Vol. 11, No. 2, pp. 178–189.) Experiments with commercial thyratrons indicate that the recovery time is a function of the instantaneous effective grid potential and is independent of previous grid-potential variations provided that no abrupt changes have occurred shortly before the grid regains control. Such changes set up an unstable charge distribution in the plasma and sheaths within the tube, this unstable state passing to a quasi-stationary one in a time dependent on diffusion.

621.396.615.14 **2677**

A New Wide-Range, High-Frequency Oscillator.—O. Heil & J. J. Ebers. (*Proc. Inst. Radio Engrs*, June 1950, Vol. 38, No. 6, pp. 645–650.) Wide-range tuning in a Barkhausen type of oscillator is achieved by concentrating electrons from a highly efficient electron gun and also concentrating the electric field of a cavity resonator at the point where the electron beam has its greatest density. Although efficiency is low, variation of circuit capacitance alone gives a 3 : 1 tuning range, since the resonator gap capacitance is small. The oscillator construction is described and operating characteristics are given, output powers of 0.1–1 W being obtained in the wavelength range 4.5–12 cm.

621.396.615.141.2 **2678**

Resonance Frequencies of the Space Charge in a Magnetron.—P. Fechner. (*C. R. Acad. Sci., Paris*, 22nd May 1950, Vol. 230, No. 21, pp. 1848–1849.) Analysis is effected for values of anode voltage and magnetic field such that the magnetron cannot oscillate, h.f. excitation being introduced from an auxiliary source. Expressions are derived relating the resonance frequency of the vibrating space-charge electrons to the value of the electric field, for both whole-anode and multicavity magnetrons.

621.396.615.141.2 : 534.415 **2679**

Stroboscopic Mapping of Time-Variable Fields.—Marton & Reverdin. (*See* 2584.)

621.396.615.141.2† : 621.317.361 **2680**

Measurement of the Resonance Frequency of the Space Charge in a Coaxial Magnetron.—P. Fechner. (*C. R. Acad. Sci., Paris*, 10th July 1950, Vol. 231, No. 2, pp. 124–125.) The formula connecting magnetic field H with interelectrode voltage V at resonance (see 2678 above) is verified by measurements made by the following method. The non-oscillating magnetron is energized from a klystron source coupled to it by a matched coaxial line. An attenuator inserted in this line serves to increase the variations of impedance as V is altered. The resonance condition is determined by means of a crystal detector at an electric-field antinode of the coupling line.

621.385 **2681**

Röhren Vade-Mecum 1950. [Book Review]—P. H. Brans. Publishers: Brans-Verlag, Antwerp, 8th edn 1950, 508 pp., 15.40 Swiss francs. (*Bull. schweiz. elektrotech. Ver.*, 27th May 1950, Vol. 41, No. 11, p. 493. In German.) Includes the data of former editions combined with particulars of the latest valves: viz. 9-element valves, accelerometers, projection tubes, phasitrons, planar triodes, crystal diodes, etc. Contents list and instructional notes are printed in eight languages.

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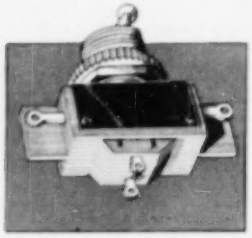

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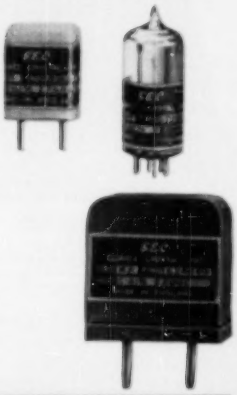

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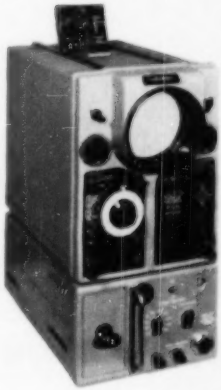

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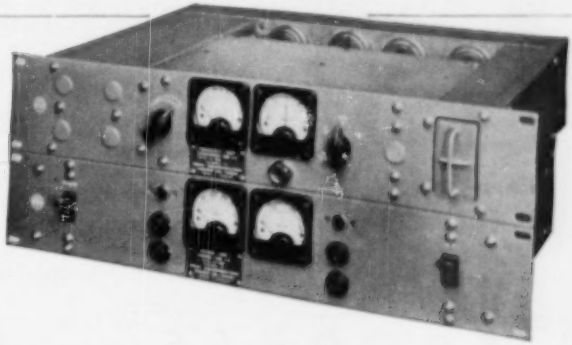

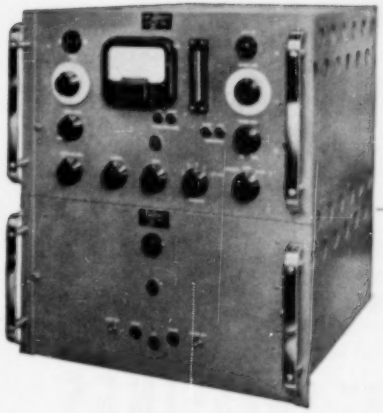

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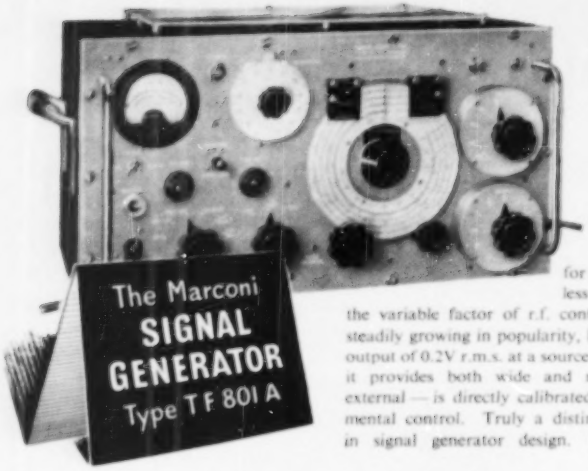

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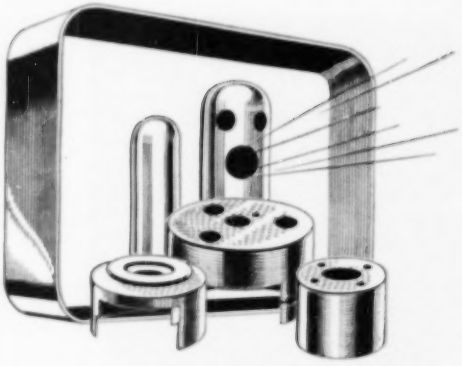

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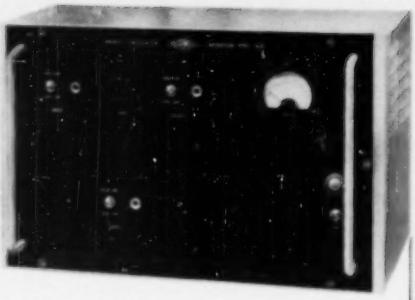

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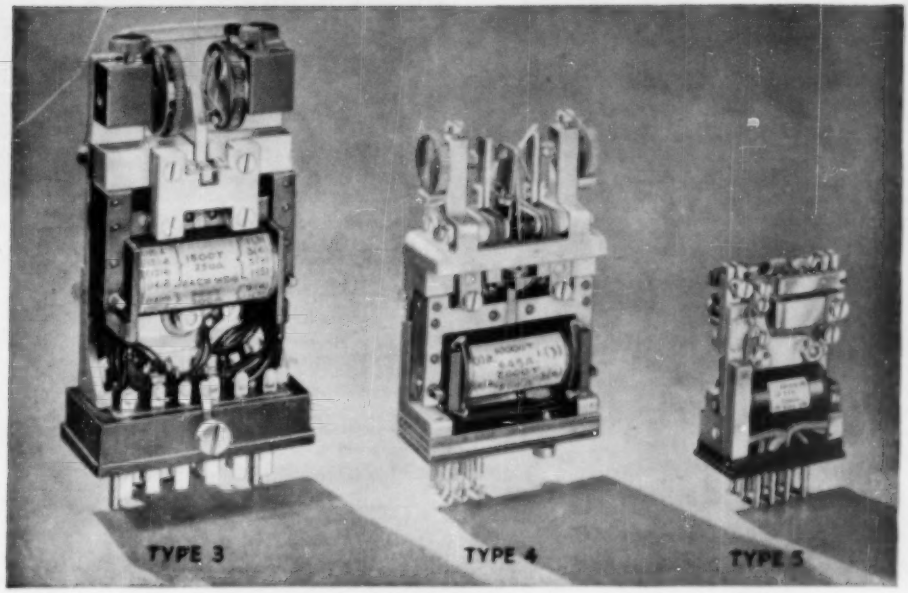

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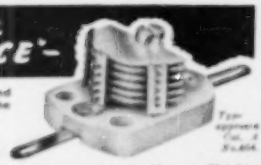

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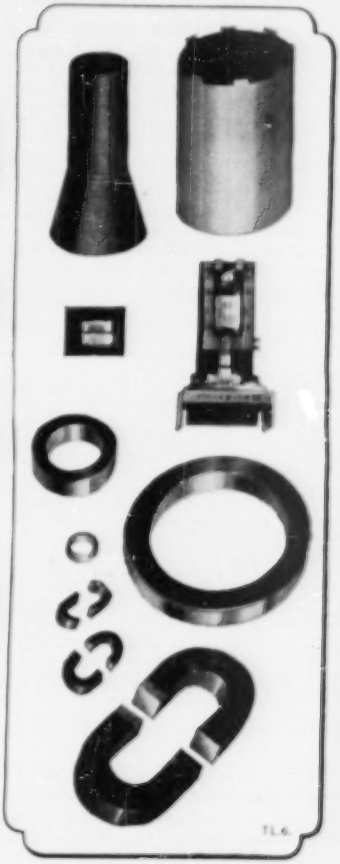

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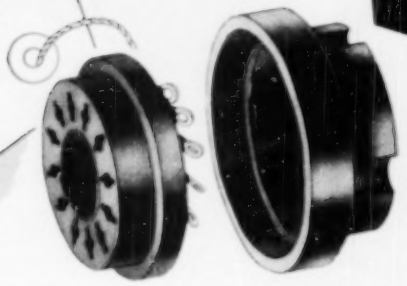

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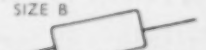

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